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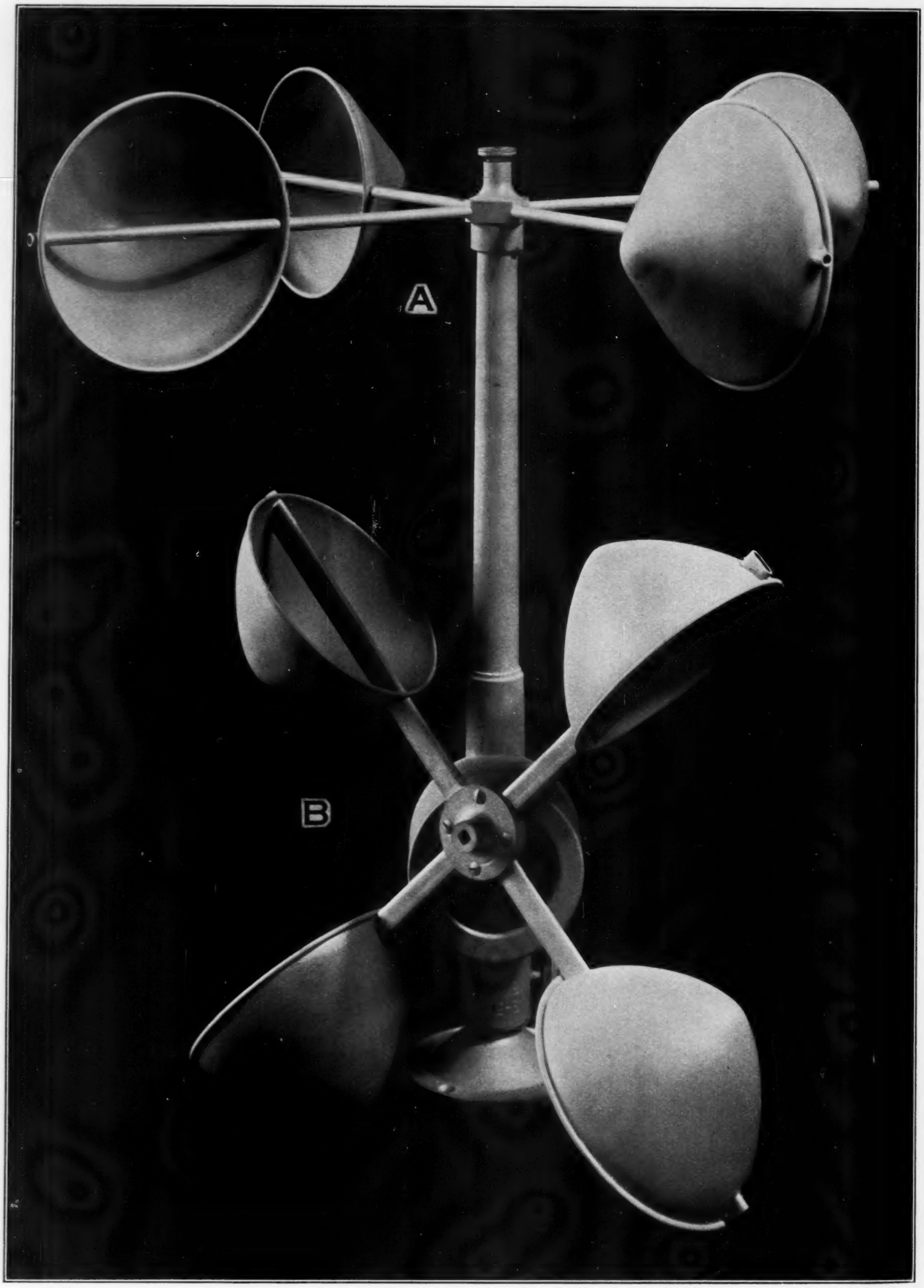
CORRECTION

Volume 61, December 1933, page 352: Second column, under "Literature Cited", in the fourth line, "2d Ed." should be "3d Ed."; in same line, change "1928" to "1930."



Cup-wheel anemometers: A, No. 24 in the tables, with 90° cone backs and medium beaded edges; B, new form of beaded cup wheel with hollow, elliptical arms.

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Editor, W. J. HUMPHREYS

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RECENT ADVANCES IN ANEMOMETRY [1]

By CHARLES F. MARVIN

[Weather Bureau, Washington, May 1934]

Quite important advances have been made in the theory and the practical development of the cup anemometer within the past 2 years.

On the theoretical side this progress consisted chiefly in measuring all the fundamental aerodynamic forces on various forms and sizes of cups, singly and in combination, under as wide a range as practicable of cup wheel sizes and values of Reynold's number. A research project of this character for the Weather Bureau is still in progress at Langley Field by the National Advisory Committee for Aeronautics. When all the observational data are available it is believed they will be of great value in the development of really useful aerodynamic relationships between wind velocity and some measure of the angular velocity of the cups, such as the revolutions per minute, or cup turns per unit wind travel.

Purpose of this note.—My principal objects in this brief paper are: (1) to advocate certain simple and exact methods of testing rotation anemometers; (2) to plead for the publication of *original observations* by others who test anemometers; and (3) to present in general terms the systematic characteristics of the performances of cup anemometers, illustrated by results from recent tests.

Every investigator owes it to himself, and to the cause of science, to present his original observations as fully as possible, and to retain an adequate number of digits in the numerical values which constitute the basic test.

I must deplore a prevailing tendency of withholding original observations and presenting only arbitrarily "smoothed" and "adjusted" values rounded out to a scale of whole velocity units. In the interest of final accuracy in the analysis of test data the decimal place of "hundredths" should be retained in both the true and the indicated wind velocity, particularly for moderate or low values, and especially when the velocity unit is meters per second, which is really a very large and coarse unit. I do not pretend to claim that hundredths of meters per second or hundredths of miles per hour are accurately shown in ordinary test data at a particular velocity nevertheless their retention is a valuable aid to the computor, whose task is one of segregating the inevitable errors of observation from the small and obscure, but important, systematic characteristics of test data and definitely evaluating those characteristics. The writer who withholds original observational data and needlessly discards useful fractional values in anemometer tests is guilty of rejecting the most informative portion of his data and passing on to other students values that exaggerate the errors of observation and obscure the systematic performanee features of the instruments. Any good cup anemometer is highly dependable in its action and fully justifies refinements in testing it.

Sound-testing technique.—There are, of course, good and poor ways of testing the performance of any rotation anemometer. Nearly all cup anemometers as now made for daily use are already provided with electrical contact makers which actuate a buzzer, or which may be used to make a chronographic record. Each buzz or registration then represents a certain exact number of cup turns, which varies widely in different instruments and ranges from 8 and a fraction to 500 or more.

These available provisions are entirely adequate, for all ordinary purposes. Other special provisions are more or less fanciful or superfluous. For practical tests I regard audible contacts and counting facilities for every 64 cup turns as all-around adequate. A test at a definite uniform velocity, W, consists simply in measuring accurately, by means of a good stop watch, the whole number of electrical contacts, C, in an elapsed time, t seconds. Chronographic registration, in my mind, is quite superfluous, or even objectionable, especialy because it generally requires quite special equipment, with fast moving paper feed and some one, from such record sheets, must later count out the actual number of registrations made and ascertain the elapsed time in seconds. In reality these essential data are more promptly, more easily, and just as accurately secured at the time of the test by the use of a stop watch and the counting of audible contacts. If each contact counted represents, say n cup turns, then R, the number of cup turns per minute, $=60nC\div t$.

I cannot emphasize too strongly, that for anemometer tests, all original observations consist essentially of W, the true speed of the wind in the tunnel, C the number of contacts counted, and t the elapsed time in seconds. Out of these we calculate R. This derived basic datum, R, the cup revolutions per minute, is a perfectly definite and exact index of the behavior of the particular cup wheel tested at the corresponding velocity, W. We also have another equally fundamental datum or index of cup behavior, namely, N, the number of cup wheel turns per mile or other unit of wind travel. Both R and N are numerical magnitudes for each particular cup wheel which are wholly free from any kind of personal assumptions such as are involved when we employ the familiar concept "indicated velocity." In these cases we must

[1] Paper presented at the April 1934 meeting of the American Meteorological Society, Washington, D.C.

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say, for example, each turn of the cups represents say 2.5 meters of wind travel, or that 500 cup turns represent a mile. Both assertions are erroneous except possibly for some one particular velocity which can not be known a priori. Nevertheless, the datum, "indicated velocity, V", is very useful in its proper place.

Fortunately these basic data R, N, and V are rigorously related by very simple equations, which for English units are:

$$NW = 60R = AV = \text{Cup wheel turns per hour} \quad (1)$$

In the last term, A is the so-called "gear train number", or the assumed number of cup wheel turns per indicated mile of wind travel.

Each datum N, R, and V is directly derivable from the basic test data by the following rigorous equations:

$$N = \frac{3600nC}{tW} \quad (2)$$

$$R = \frac{60nC}{t} \quad (3)$$

$$V = \frac{3600nC}{tA} \quad (4)$$

In the last term the ratio $\frac{n}{A}$ is generally a simple fraction like $\frac{1}{30}$, $\frac{1}{60}$, etc.

Group means.—The formation of group means of numerous individual observations derived from different tests and at irregular spacing of conditions is necessary in practically all classes of data, not only to lessen the inevitable errors of observation but also to reduce labor in the analytical processes of curve fitting, etc. Unless this is done with a careful regard for right and wrong methods the inherent accuracy of the original data will be reduced rather than preserved. The principle is illustrated in figure 2. Points a and b are assumed to be observations represented by the curved line passing near them. The ordinary arithmetical mean values of the two coordinates of a and b locate a new point c, which falls quite a bit off the curve depending upon the number of observations combined and how much the line is curved between the points. In the application of this idea to anemometer test data it will be remembered that, as shown in figure 1, values of R or V plotted against W form nearly straight lines throughout their entire range. It is best, therefore, to form group means of data between R or V and W. The corresponding values of other data, such as N, should then be computed from the R or V data by the use of the rigorous relations in equation 1.

The use of the foregoing rigorous equations and relations greatly facilitate the calculation of test data with the minimum of arithmetical inaccuracies.

Friction.—Actual measurements by stroboscopic methods of the energy dissipated by the friction of various forms of plain and ball bearings in anemometers have vastly clarified this heretofore rather obscure subject.

Friction, unless excessive, is of very minor importance at all wind velocities above 20 or 30 miles per hour. It is however, of great importance at all low velocities and should be reduced to the utmost in any instrument claiming to be a high standard.

This result, including high durability and freedom from frequent demands for lubrication can be secured only by the use of ball bearings. Four prerequisites must be satisfied:

(1) The bearings must be of the highest design and grade. Just any old ball bearing will not do.

(2) The entire load and lateral thrust is best carried on the top bearing.

(3) The cup wheel hub must be designed so that the plane of the cup wheel arms coincides exactly or nearly with the plane of the balls in the top bearing. When so arranged the lateral thrust and attendant friction at the bottom end of the spindle is mostly eliminated.

(4) The ball bearing at the bottom end of the spindle should be of small diameter and designed to carry lateral thrust only. A small plain bearing such as now in use, but without the steel step, is quite sufficient.

Every cup wheel remains stationary for certain very feeble winds. It is difficult to evaluate the exact low velocity, W_0, which is just adequate to keep the cups turning. My best evaluation of W_0 for the new instrument now in experimental use is about 0.3 mile per hour. The new forms of cup wheel will just turn very slowly in this wind.

In a few types, such for example as the heated anemometer which furnished such a remarkable record of superhurricane winds at Mount Washington April 11 to 12, 1934, the instrument simply fails to run at low and moderate velocities because of relatively large frictional effects. While these effects are unimportant at high wind velocities, nevertheless excessive friction always causes large scale corrections, generally affecting both low and high velocities. In other words, small-scale corrections over a wide range of velocities are impossible unless the friction is a minimum. The curvature of the anemometer law must also be a minimum.

Characteristics of cup wheel performance.—We now have numerous tests on several different 4-cup systems. Some of these were made in a rather ill-adapted vertical jet wind tunnel at the Daniel Guggenheim Airship Institute at Akron, Ohio, others at the Bureau of Standards, and still others at the Langley Memorial Laboratory of the National Advisory Committee for Aeronautics. While minor systematic differences of the order of 4 percent in extreme cases are shown in results from these different sources, the major characteristics of cup wheel performance stand out boldly in all. Furthermore, even though the test data available to me on 4-cup anemometers is far superior to and in excess of that on 3-cup wheels, and especially at higher velocities, nevertheless from the most critical study I can make I can find nothing magical or superior in 3-cup systems as a type. Both devices are actuated by the same general aerodynamic forces. Under conditions of use equally favorable to each, their performance cannot in the very nature of things differ except in quite unimportant details. This assertion will, I believe, be borne out by any analysis by rigorous methods of any original observations available.

If we plot R or V against W, all good anemometer tests, if very carefully examined, fall in a systematically curved line convex downward, cutting the axis of W at a definite value, W_0, fixed by the instrumental friction, see figure 1, which is not drawn to scale and exaggerates the effects. If actual good observations were plotted to scale in this diagram the first impression would be that the line is practically straight, and the inattentive student is quite prone to seize upon the straight line as an entirely adequate approximation to cup-wheel per-

formance. The slight curvature is at first strong, thereafter the line asymptotically approaches a straight line. It will not do, however, to ignore the real systematic curvature. It will not do to substitute a straight line as an approximate representation for the anemometer law. Exactitude in anemometry requires that the curvature of this line be evaluated as best we can. The empirical method [2] developed by me for doing this has stood the test of quite severe usage, and especially adapts itself to the satisfactory representation of new and better observations than originally available. The ultimate solution of this problem of inherent curvature shown by all observations will of course be most completely attained by the analysis of the fundamental aerodynamic data now being gathered and studied. Pending this accomplishment we are finding, by empirical studies, not only how to evaluate the curvature best but especially how to design cup systems which show a minimum amount of curvature in performance.

If, instead of plotting R or V against W, we plot that other important index of cup wheel performance, namely,

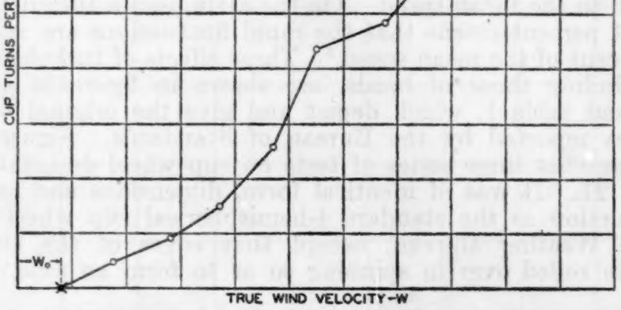

FIGURE 1.—Diagrammatic representation of the main characteristics between true wind velocity and cup turns per minute which are directly proportional to indicated velocity. The line starts at a point W_0, trends convex towards the axis of the true wind, with a small but important amount of curvature, becoming asymptotically straight.

N = cup turns per mile, we get a very strongly curved line shown diagrammatically, that is, not to scale, in figure 2. This line must of course cut the axis of W at the point W_0. The values of N rise rapidly and asymptotically approach a limiting high value. In a word, the curve shown by many sets of test values of N and W for anemometers possesses all the essential characteristics of the hyperbola when referred to coordinate axes parallel to its asymptotes. Numerous trials with very diverse test data now show that this empirical curve represents anemometer performance to an extent which is really quite remarkable. The form of the full equation for use with observations of N and W is:

$$f+Wb+Na+NW=0 \tag{5}$$

Since $NW=AV=60R$ similar equations for the analysis of test values of W and V or W and R are:

$$f'+Wb'+aV/W+V=0 \tag{6}$$

$$f''+Wb''+aR/W+R=0 \tag{7}$$

[2] A Rational Theory of the Cup Anemometer, Charles F. Marvin. MONTHLY WEATHER REVIEW, vol. 60, February 1932, pp. 43-57.

in which

$$f'A=60f''=f \text{ and } b'A=60b''=b \tag{8}$$

In the best ordinary anemometers the friction is very slight, and experience shows that it is best in such cases to replace the absolute term in each of the basic equations by a composite term bW_0 in which W_0, as already mentioned, is the wind just adequate to keep the cups in motion and which is evaluated by good judgment based on other than the ordinary test data. This course is necessary chiefly because it is difficult to make good tests at sufficiently low velocities to evaluate W_0 directly. All the equations then take on a simpler form with only two constants to be evaluated, thus

$$(W-W_0)b+Na+NW=0 \tag{9}$$

The corresponding equations for (6) and (7) are obvious.

The least-square calculation of the parameters of equation 5 is somewhat easier than for either of the other equations, but the numerical values, theoretically, should be identical by either of the equations in the absence of

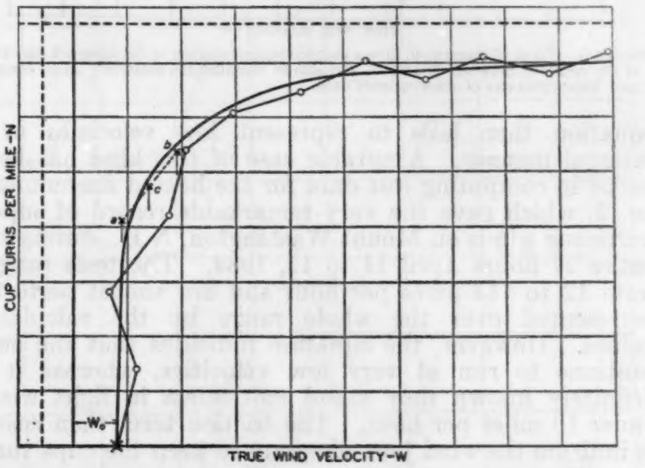

FIGURE 2.—Diagrammatic representation of the relation between true wind velocity and cup turns per mile. The characteristic features are those of the hyperbola referred to axes parallel to its asymptotes.

arithmetical inaccuracies. However, small differences necessarily arise because of inherent errors and irregularities in the observational data, and because the hyperbolic equation is only empirical and only imperfectly fits even the best observations. Parameters calculated from equation 5, moreover, have greater value because they are wholly free from any assumptions involved in the arbitrary number A which is required in all the V, W, relationships. Experience in these calculations indicates a strong advantage in favor of the use of the N, W, relationship. The rigorous equation 1 always easily permits any exact transformations desired.

The remarkable adaptability of the hyperbolic equation to the anemometer is the definite and specific significance of its constants. As already stated, W_0 represents the quite definitely known low wind velocity just adequate to keep the cups turning. We may continue to regard f, f', and f'' as friction terms even when large, because they change greatly in value as soon as the friction becomes large and causes the cups to stand still or move very slowly at low velocities.

The important constant a is exclusively a measure of the curvature in the V, W, or the R, W, relationship. This is clearly obvious from equations 6 and 7 because both

become strictly straight or nearly straight lines when $a=0$ or is very small.

Finally, b, b', or b'' is a limitation or asymptotic value of the number of cup turns per mile in one case and in the other the limitation to which the ratio V/W or R/W approaches, that is, the limiting direction of the tangent to the line at very high velocities.

Whenever the friction is considerable all three parameters of the hyperbolic equation must be evaluated from the test data if we are to secure a good fit to the observations of either N or V. When f or f' becomes large it also takes on the negative sign and the resulting

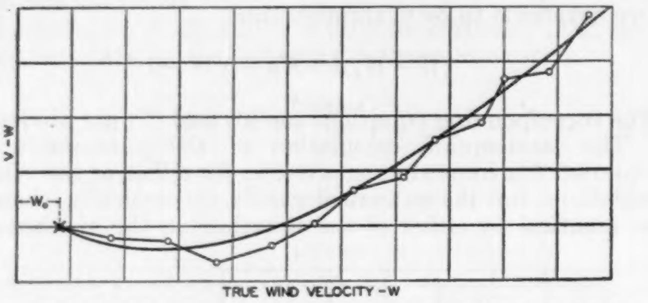

FIGURE 3.—Form of diagram to give a graphic representation of the inherent curvature of the relations between W and V, and also to visualize the relatively small conflicts and inconsistencies of observational data.

equation then fails to represent low velocities in a rational manner. A notable case of this kind has been found in computing test data for the heated anemometer no. 2, which gave the very remarkable record of superhurricane winds on Mount Washington, N.H., during the entire 24 hours April 11 to 12, 1934. The tests ranged from 12 to 143 miles per hour and are almost perfectly represented over the whole range by the calculated values. However, the equation indicates that the cups continue to run at very low velocities, whereas it is definitely known they stand motionless in light winds under 10 miles per hour. The friction term then ceases to indicate the wind just adequate to keep the cups turning, and its presence in the equation serves the useful purpose of analytically helping the equation to fit the observational data more closely.

Omitting at this time further discussion of the hyperbolic equation, attention is asked to the best way, the only way I believe, of showing in a striking, graphic way, the real curvature and other characteristics of test data. This result is easily attained by plotting the difference-values, $V-W$, against W as shown in figure 3, still not drawn to scale.

In diagrams of $V-W$ plotted against W, the scale for $V-W$ can be chosen so as to bring out clearly not only the conflicts and inconsistencies in the observations but also the inherent curvature which we seek to evaluate. Only by the aid of diagrams like figure 3 can the real characteristics of test data be adequately visualized.

Values of V from test data become possible only after some value has been assigned to the gear train number A, as already explained in connection with equation 1.

I cannot overemphasize the fact that, waiving the effects of the inherent curvature in the line representing the anemometer law, the whole question of the magnitude and distribution of the difference values, $V-W$, that is, the discrepancies between the indicated and the true wind velocities, depends entirely upon the choice of A. If the original basic data are made available it is obvious that almost any desired values of V are readily computed from equation 4 at any time and to correspond to any desired value of A.

Effects of turbulence and beads.—Modern wind-tunnel tests now show that some account must be taken of the aerodynamic effects of so-called fine grained turbulence in the wind stream. This word has come to mean rapid variations of wind speed generally at the rate of 10 or more a second. Apparently it is only these rapid, irregular speed fluctuations that produce the effects to be mentioned later and since open-air winds are turbulent in this way, it must be known whether a particular instrument is affected much or little by such turbulence. Small hot-wire anemometers, actuating thermal types of miliammeters, may be used in measuring turbulence, which is then expressed as a ratio of the average fluctuation to the mean speed. On the scale used a turbulence of 1 percent means that the rapid fluctuations are ± 1.4 percent of the mean speed.[3] These effects of turbulence, including those of beads, are shown in figures 4 and 5 and table 1, which depict and give the original test data reported by the Bureau of Standards. Figure 4 represents three series of tests on cup wheel designated no. 21. It was of identical form, dimensions and construction as the standard 4-hemispherical cup wheel of the Weather Bureau, except that edges of the cups were rolled over in spinning so as to form an external so-called bead of a diameter of a little less than one-sixteenth of an inch. A slender brace wire securely attached to the extremities of the arms was stretched around the periphery of the cup wheel to strengthen it in high winds. Tests by Dr. H. L. Dryden, of the Bureau of Standards definitely indicated that the performance was not affected appreciably by this brace. Without the bead, this cup wheel by the Fergusson tests of 1922 should make fully 686 turns per mile at superhurricane wind velocities. With the bead this number was reduced to 584. By the choice of a gear

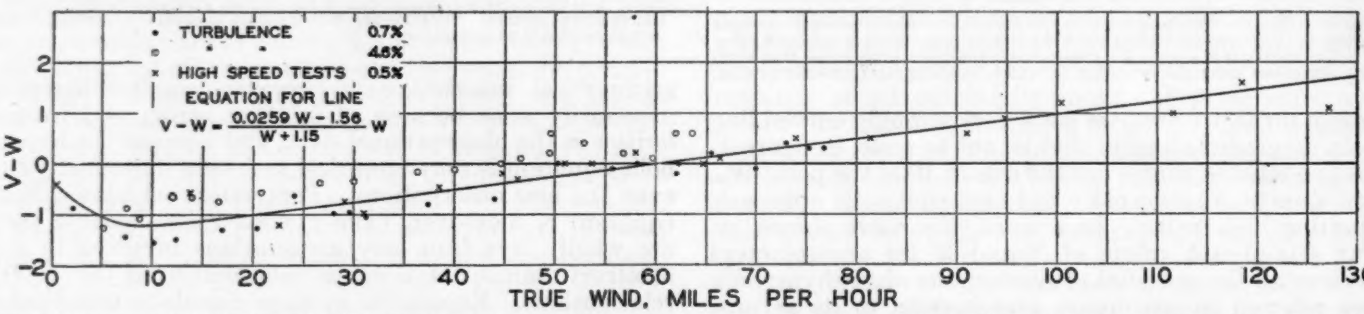

FIGURE 4.—Diagram to scale of values of $V-W$ for a new form of 4-hemispherical cup wheel with beaded edges, recently tested at the Bureau of Standards up to 130 miles per hour. The scale errors are just within 1 mile per hour at all velocities from 0 to 100 miles per hour true wind.

[3] H. L. Dryden, Turbulence, Companion of Reynolds Number. Jour. Aeronautical Sciences, vol. 1, no. 2, April 1934, pp. 67-75.

system of 570 cup turns to the indicated mile, the scale errors of this instrument fall within 1 mile per hour between 0 and 100 miles an hour.

Three pairs of tests on three identical cup wheels are shown in figure 5. The wheels are designated nos. 23, 24, and 25 in table 1, and, for brevity, 1, 2, 3 in the diagram. The cups were 90° cones with the apex bluntly rounded over. Cup wheel no. 24 is the one shown on the instrument in the halftone, (frontispiece). The arms were all 6.5 inches from axis to center of open face of the cups. The cup diameters were all nominally 4.25

(4) The overrun caused by increased turbulence is much less with beaded cups than with smooth cups.

(5) Small variations in size of beads seem to be of secondary importance in cup performance.

While the body of data now available is as yet insufficient to provide final quantitative relationships, nevertheless on the basis of data we have the percentage relationships may be stated about as follows:

(6) The percentage overrun effects due to increased turbulence is higher for high velocities than for moderate and low velocities.

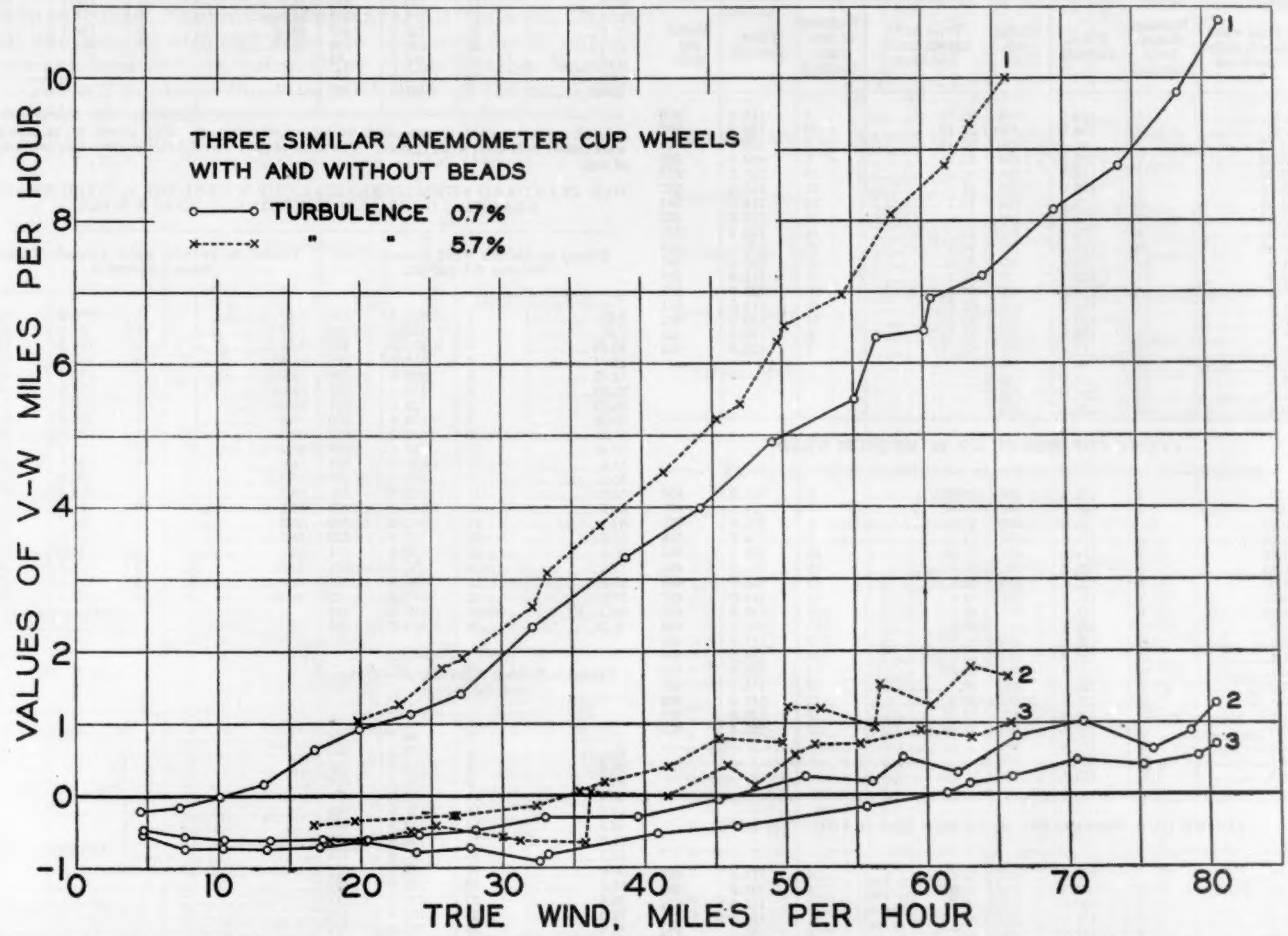

FIGURE 5.—Graphic representation of six test runs in pairs on three 4 cone cup wheels of like dimensions except that no. 1 had smooth surfaces without beads. No. 2 had external beaded edges about one-sixteenth inch in diameter. No. 3 had external beaded edges about one-eighth inch in diameter. Dotted lines are tests with turbulence 5.7 percent. Full lines are with turbulence 0.7 percent.

inches. No. 23 was smooth and without bead. The bead on no. 24 measured about one-sixteenth inch; that on no. 25 was almost one-eighth inch in diameter.

Lack of space at this time prevents any long discussion of this new question. However, we may say categorically:

(1) That cup forms seem to run faster in a turbulent than in a nonturbulent wind stream.

(2) The overrun is much greater for cups with smooth external surfaces. This is especially true of smooth hemispherical cups such as all the old 3- and 4-cup standard wheels.

(3) Cone-shaped cups, especially when provided with external beads, seem to run more slowly than the hemispherical forms.

(7) The percentage overrun on a 4 cone cup wheel without beads, at velocity of about 20 miles per hour, was about 3 percent when the rapid changes of wind speed were about 8 percent of the mean speed.

(8) The overrun was only 1 percent for these same cups with beads a little over one-sixteenth inch diameter.

(9) The run of the old standard nonbeaded cups was more than 17 percent greater than that of the same cups with a comparatively small bead.

(10) Dr. Dryden, of the Bureau of Standards, made the crucial tests on an old standard hemispehrical 4-cup rotor which indicated unequivocally that the marked change in rate that had been noticed in beaded cone and hemispherical cups was due to the bead rather than to the cup form.

(11) Cone-shaped cups seem to possess advantages for standard anemometers over hemispherical cups, but additional tests are needed to evaluate important secondary effects.

TABLE 1.—*Original test data on anemometer cup wheels nos 21, 23, 24, and 25, as reported by the Bureau of Standards in letters dated Sept. 22, 1933, Jan. 21 and Apr. 12, 1934*

4 CONE CUP WHEEL NO. 23, WITHOUT BEAD

Turbulence, 0.7 percent				Turbulence, 5.7 percent			
True wind speed, miles per hour	Number of contacts counted	Time, seconds	Turns per mile	True wind speed, miles per hour	Number of contacts counted	Time, seconds	Turns per mile
4.46	1	113.0	458	19.75	5	115.4	505
7.32	2	134.0	470	22.73	6	120.0	507
10.07	2	95.4	480	27.15	7	115.6	514
13.20	3	107.8	486	32.25	8	109.8	520
16.78	4	110.2	498	36.95	10	118.2	527
19.91	5	115.2	502	41.5	11	114.8	532
23.48	6	117.0	504	45.3	12	114.0	536
27.10	7	117.8	505	47.0	13	119.0	537
32.20	8	111.2	515	49.7	14	120.0	541
38.80	10	114.0	521	54.3	16	125.4	542
44.1	12	119.8	523	57.9	16	116.4	547
49.2	14	124.2	528	61.7	17	115.8	548
55.1	15	118.8	528	66.0	19	120.0	553
56.7	15	114.2	534	63.5	18	118.6	551
60.1	17	122.6	532	50.2	13	110.0	543
64.3	18	120.8	534	33.15	9	119.2	525
69.4	19	117.6	537	25.77	7	122.0	514
74.0	20	116.0	537				
78.2	22	120.0	540				
81.2	23	120.0	544				
60.6	18	128.0	535				

4 CONE CUP WHEEL NO. 24, MEDIUM BEAD

4.70	1	113.4	432	16.68	4	118.0	468
7.62	2	136.2	444	19.60	5	124.6	472
10.39	2	98.2	452	26.50	6	109.8	475
13.56	3	111.2	459	32.35	8	119.2	478
17.32	4	114.8	464	37.25	10	128.2	483
20.50	5	120.6	466	41.7	10	114.0	484
24.07	6	122.4	469	45.3	12	125.0	488
28.07	7	121.8	471	49.8	12	114.0	487
32.95	8	117.6	471	52.5	13	116.2	491
39.5	10	122.4	477	56.3	15	125.8	488
45.2	12	127.6	480	60.3	15	117.0	491
51.4	13	120.8	483	63.2	16	118.2	494
56.1	14	119.4	482	65.8	17	121.0	492
62.2	16	123.0	482	56.7	14	115.4	493
66.4	17	121.4	486	50.2	12	112.0	492
71.1	18	119.8	487	35.35	9	122.0	481
76.0	19	119.0	484	26.66	7	127.4	475
80.5	20	117.4	488				
78.7	20	120.6	486				
58.3	15	122.4	484				

4 CONE CUP WHEEL NO. 25, LARGE BEAD ABOUT ⅛ INCH

4.71	1	115.0	426	17.78	4	111.8	463
7.62	1	69.8	433	19.97	5	124.0	465
10.34	2	100.0	446	25.30	6	115.8	472
13.45	3	113.2	454	31.17	7	110.0	471
17.10	4	117.2	460	35.75	8	109.4	472
20.27	5	122.2	465	41.6	10	115.4	480
23.90	6	124.6	465	45.9	11	114.0	484
27.70	7	124.6	467	47.8	12	120.2	482
33.20	8	118.6	468	50.7	12	112.4	485
40.9	9	107.0	474	55.3	14	120.0	486
46.5	12	125.0	476	59.6	15	119.0	488
55.7	14	121.0	479	63.2	16	120.0	487

TABLE 1.—*Original test data on anemometer cup wheels nos. 21, 23, 24, and 25, as reported by the Bureau of Standards in letters dated Sept. 22, 1933, Jan. 21 and Apr. 12, 1934*—Continued

4 CONE CUP WHEEL NO. 25, LARGE BEAD ABOUT ⅛ INCH—Contd.

Turbulence, 0.7 percent				Turbulence, 5.7 percent			
True wind speed, miles per hour	Number of contacts counted	Time, seconds	Turns per mile	True wind speed, miles per hour	Number of contacts counted	Time, seconds	Turns per mile
61.4	15	117.2	481	66.0	17	121.8	487
66.0	17	123.2	482	52.1	13	118.2	487
70.6	17	114.8	483	36.25	9	119.0	481
75.3	20	126.8	483	30.02	8	130.4	471
79.2	20	120.4	483	23.53	5	104.2	470
80.5	20	118.2	485				
63.0	16	121.6	482				
32.60	8	121.2	467				

In all cases 1 contact, C, represents 64 cup-wheel turns = n. Cup wheels 23, 24, and 25 were tested in 54-inch wind tunnel. The arms of each were 6.5 inches from axis to center of cup.

OLD STANDARD 4-HEMISPHERICAL CUP WHEEL NO. 21, WITH SMALL BEADED EDGES AND PERIPHERAL BRACE WIRE

Tested in 54-inch wind tunnel—Turbulence 0.7 percent				Tested in 54-inch wind tunnel—Turbulence 4.6 percent			
2.07	1	319.2	349	5.17	1	106.0	421
7.45	2	134.6	460	7.50	1	61.0	503
10.23	3	139.8	483	8.85	2	104.0	501
12.41	3	111.0	502	11.36	3	113.8	534
17.02	5	128.6	526	14.05	4	121.4	540
20.36	6	126.4	537	16.60	6	152.8	545
24.12	7	123.0	544	20.82	6	119.6	555
28.00	8	119.6	550	30.00	9	122.6	564
31.15	9	121.0	550	36.34	11	122.6	569
37.43	11	121.4	558	40.0	12	121.6	569
44.0	13	121.0	564	44.6	14	126.8	570
50.3	15	120.6	570	46.6	15	130.0	571
55.7	17	123.6	569	49.5	17	138.4	572
58.2	18	125.0	570	52.9	16	121.4	574
62.1	19	124.0	569	56.8	18	127.6	573
65.5	21	129.2	572	59.7	19	128.4	571
70.0	22	126.8	571	62.0	19	122.8	574
73.0	22	121.2	573	63.6	19	119.6	576
76.8	23	120.6	573	49.6	15	121.0	577
75.3	22	117.6	573	26.59	8	123.4	562
62.3	19	123.2	570				
29.56	9	127.0	552				
Tested in 36-inch wind tunnel—Turbulence 0.5 percent							
13.8	3	98.7	506				
22.5	6	113.5	540				
29.0	8	114.4	554				
30.9	9	121.3	552				
38.4	11	117.0	564				
44.7	14	127.0	568				
46.3	14	123.0	566				
51.0	16	126.9	570				
53.7	16	120.4	571				
58.0	18	125.0	572				
64.7	20	125.0	570				
66.4	20	121.6	571				
74.0	23	124.8	574				
81.4	25	123.4	574				
91.0	28	123.6	574				
94.8	29	122.5	576				
100.5	31	123.2	577				
111.6	35	125.6	575				
118.5	18	60.6	578				
127.2	20	63.0	576				

SPECIAL SERIES OF SOUNDING-BALLOON OBSERVATIONS MADE DURING THE WINTER OF 1929-30.

By L. T. SAMUELS

[Weather Bureau, Washington, D.C.]

Table 1 contains a summary of the results obtained from sounding balloons released from 10 selected Weather Bureau stations. In addition to these observations others were gotten at the same time by kite flights made at frequent intervals at the aerological stations of the Weather Bureau, and by special airplane flights by the United States Navy at several Naval Air Stations. None of the kite or airplane data are published here, but all are available at the Central Office of the Weather Bureau.

Table 2 contains the tabulated data of the sounding-balloon observations.

TABLE 1.—*Summary of sounding-balloon observations*

DECEMBER 1929

Station	Date	Time of release, 75th mer.	Stratosphere: Height of base, meters, M.S.L.	Stratosphere: Temperature at base	Maximum height reached (meters) M.S.L.	Minimum temperature recorded	Meteorograph found at—
				° C.		° C.	
Amarillo, Tex	27	8:10 p.			10, 523	−57. 7	Clarendon, Tex.
	28	2:00 a.	Not returned				
	28	8:00 a.			9, 740	−49. 5	Vinson, Okla.
	28	2:00 p.	Record obliterated				Wellington, Tex.
Cincinnati, Ohio	28	2:13 a.			7, 097	−39. 2	New Lexington, Ohio.
	28	8:15 a.	10, 150	−53. 7	20, 584	−54. 3	Ray, Ohio.
	28	2:09 p.	9, 755	−51. 6	22, 321	−51. 6	Crooksville, Ohio.
	28	8:15 p.	Record obliterated				New Concord, Ohio.
Concordia, Kans	28	2:15 a.			8, 135	−53. 6	Everest, Kans.
	28		Record obliterated				Alma, Kans.
	28	2:06 p.	Record obliterated				Admire, Kans.
	28	7:56 p.			6, 976	−31. 0	Lafayette, Ala.
Davenport, Iowa	28	8:16 a.			7, 316	−40. 2	Sugar Grove, Ill.
	28	2:04 p.	7, 792	−52. 3	16, 293	−52. 3	Mendota, Ill.
	28	8:00 p.	Not returned				
	29	2:05 a.			7, 624	−49. 4	Oakley, Ill.
Denver, Colo	28	1:49 a.			7, 379	−37. 1	Eads, Colo.
	28	7:51 a.	Record obliterated				Simla, Colo.
	28	1:43 p.			9, 286	−50. 6	Colorado Springs, Colo.
	28	7:46 p.			8, 179	−35. 4	Eastonville, Colo.
Little Rock, Ark	27	8:06 p.	Record obliterated				Olive Branch, Miss.
	28	1:54 a.	Not returned				
	28	7:57 a.			9, 764	−43. 5	Martin's Mill, Tenn.
	28	1:50 p.	10, 093	−47. 1	21, 559	−60. 2	Michigan City, Miss.
Nashville, Tenn	28	2:01 a.			8, 210	−40. 2	Yancey, Ky.
	28	8:07 a.			9, 561	−45. 5	Glenmary, Tenn.
	28	1:55 p.	10, 684	−50. 7	18, 025	−56. 3	Balkan, Ky.
	28	8:02 p.			8, 414	−43. 1	Bucu, Va.
St. Louis, Mo	28	2:00 a.	Not returned				
	28	8:00 a.			7, 734	−42. 8	
	28	2:00 p.	Not returned				
	28	8:00 p.	Not returned				
Sioux City, Iowa	28	8:12 a.	Not returned				
	28	2:12 p.	Not returned				
	28	8:25 p.			8, 620	−48. 6	Henderson, Iowa.
	29	1:56 a.	9, 790	−63. 7	19, 530	−65. 0	Griswold, Iowa.
Vicksburg, Miss	27	8:04 p.	Record obliterated				Moundville, Ala.
	28	1:58 a.	Not returned				
	28	8:00 a.			6, 386	−17. 0	Boligee, Ala.
	28	2:00 p.	Not returned				

JANUARY 1930

Station	Date	Time of release, 75th mer.	Stratosphere: Height of base, meters, M.S.L.	Stratosphere: Temperature at base	Maximum height reached (meters) M.S.L.	Minimum temperature recorded	Meteorograph found at—
Amarillo, Tex	6	2:00 p.	Not returned				
	6	8:00 p.	Not returned				
	7	2:00 a.			9, 770	−55. 2	Higgins, Tex.
	7	8:02 a.	Not returned				
Cincinnati, Ohio	6	8:03 p.			10, 746	−57. 0	Asheville, Ohio.
	7	2:05 a	12, 875	−69. 9	18, 896	−69. 9	West Bedford, Ohio.
	7	8:00 a.	Not returned				
	7	2:12 p.			3, 115	−0. 2	Mount Vernon, Ohio.
Concordia, Kans	6	2:03 p.			8, 951	−40. 7	Nebraska City, Nebr.
	6	7:55 p.	Record obliterated				Steinauer, Nebr.
	7	2:09 a.			8, 732	−49. 0	Shambaugh, Iowa.
	7	8:09 a.	11, 408	−36. 7	13, 386	−36. 7	Rockport, Mo.
Davenport, Iowa	6	1:59 p.	Record obliterated				New Garden Prairie, Ill.
	6	8:04 p.	Not returned				
	7	2:01 a.	Record obliterated				Zenda, Wis.
	7	8:03 a.			10, 559	−61. 1	West McHenry, Ill.
Denver, Colo	6	1:43 p.	8, 624	−50. 3	11, 175	−51. 1	Messex, Colo.
	6	7:57 p.	Record obliterated				Hillrose, Colo.
	7	1:51 a.			4, 220	−18. 3	Fleming, Colo.
	7		No flight made				

TABLE 1.—*Summary of sounding-balloon observations*—*Continued*

JANUARY 1930

Station	Date	Time of release, 75th mer.	Stratosphere: Height of base, meters, M.S.L.	Stratosphere: Temperature at base	Maximum height reached (meters) M.S.L.	Minimum temperature recorded	Meteorograph found at—
				° C.		° C.	
Little Rock, Ark	6	2:00 p.	Record obliterated				Osceola, Ark.
	6	8:04 p.	11, 406	−62. 7	16, 597	−66. 6	Monette, Ark.
	7	1:54 a.			7, 280	−15. 1	Osceola, Ark.
	7	7:59 a.	Not returned				
Nashville, Tenn	6	8:03 p.	Not returned				
	7	2:06 a.			11, 563	−57. 5	Mabie, W.Va.
	7	7:50 a.	Record obliterated				Cabell, Ky.
	7	2:00 p.	Record obliterated				Munfordville, Ky.
St. Louis, Mo	6	2:00 p.			9, 100	−42. 2	Humbolt, Ill.
	6	7:50 p.			7, 822	−36. 2	
	7	2:00 a.			6, 527	−30. 1	
	7	8:07 a.	11, 810	−73. 3	22, 750	−74. 4	Stone Bluff, Ind.
Sioux City, Iowa	6	2:43 p.	Not returned				
	6	8:08 p.	Not returned				
	7	2:04 a.	Record obliterated				Alden, Minn.
	7	8:03 a.	9, 640	−59. 6	11, 910	−60. 2	Burt, Iowa.
Vicksburg, Miss	6	8:15 p.	Record obliterated				Sturgis, Miss.
	7	1:58 a.	Not returned				
	7	7:58 a.	11, 307	−70. 0	17, 780	−70. 0	Brookville, Miss.
	7	2:02 p.	11, 540	−60. 0	14, 089	−62. 5	Philadelphia, Miss.

TABLE 2.—*Tabulated data of sounding-balloon observations*

AMARILLO, TEX.

Launched 8:10 p.m., Dec. 27, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
0 00	1, 117	892. 3	5. 5		34	3. 07	sw.	3. 6	Cloudless.
0 22	1, 220	881. 1	5. 5	0. 00	35	3. 16			Isothermal.
0 55	1, 324	870. 0	7. 3	−1. 73	34	3. 47			Inversion.
	1, 500	851. 8	6. 1		34	3. 20			
3 44	1, 775	823. 4	4. 2	. 69	34	2. 80			
4 52	1, 975	803. 4	3. 7	. 25	33	2. 63			
	2, 000	800. 9	3. 5		33	2. 59			
6 20	2, 279	773. 7	1. 6	. 69	33	2. 26			
	2, 500	752. 5	. 7		32	2. 05			
8 07	2, 597	743. 8	. 3	. 41	32	2. 00			
9 37	2, 865	719. 4	−. 9	. 45	32	1. 81			
	3, 000	707. 3	−2. 0		33	1. 71			
10 53	3, 124	696. 3	−3. 1	. 85	33	1. 56			
12 08	3, 353	676. 5	−3. 5	. 17	33	1. 51			
	4, 000	623. 2	−7. 4		32	1. 05			
16 21	4, 201	606. 9	−8. 6	. 60	32	. 95			
	5, 000	548. 0	−14. 8		30	. 51			
24 26	5, 832	489. 8	−21. 2	. 77	28	. 26			
	6, 000	479. 1	−22. 7		28	. 23			
	7, 000	416. 9	−31. 4		26	. 09			
30 54	7, 116	410. 1	−32. 4	. 87	26	. 08			
	8, 000	363. 4	−37. 9		25	. 04			
37 32	8, 781	323. 4	−42. 8	. 62	25	. 02			
	9, 000	313. 1	−44. 6		25	. 02			
41 02	9, 786	278. 3	−51. 1	. 83	26	. 01			
	10, 000	267. 6	−53. 0		25	. 01			
44 28	10, 523	246. 2	−57. 7	. 90	23	(1)			Adiabatic.

1 Less than 0.01 mb.

Launched 8 a.m., Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	1, 117	893. 9	−0. 5		64	3. 75	n.	3. 6	Cloudless.
0 30	1, 180	888. 0	. 3	−1. 33					Inversion.
0 58	1, 240	880. 0	1. 2	−1. 50					Inversion.
2 14	1, 440	859. 0	3. 1	−. 95					Inversion.
	1, 500	851. 0	2. 9						
2 58	1, 540	847. 0	2. 7	. 40					
	2, 000	801. 0	3. 1						
5 46	2, 050	797. 0	3. 1	−. 08					Inversion.
8 24	2, 440	756. 0	1. 0	. 54					
	2, 500	750. 0	1. 3						
9 54	2, 650	736. 0	2. 1	−. 52					Inversion.
	3, 000	705. 0	−. 3						

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

AMARILLO, TEX.—Continued

Launched 8 a.m., Dec. 28, 1929 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
14 34	3,470	664.0	−3.7	0.71					
	4,000	621.0	−8.1						
	5,000	545.0	−17.3						
23 06	5,300	522.0	−20.1	.90					
	6,000	476.0	−25.1						
30 24	6,930	419.0	−31.8	.72					
	7,000	414.0	−32.1						
	8,000	358.0	−37.8						
38 00	8,850	317.0	−42.5	.56					
	9,000	310.0	−43.7						
42 24	9,740	277.0	−49.5	.79					

CINCINNATI, OHIO

Launched 2:13 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Relative	Vapor pressure	Direction	Velocity	Remarks
0 00	229	994.6	1.1		87	5.75	n.	0.9	10 St., NW.
	500	961.0	−.9		91	5.16			
	1,000	902.1	−4.6		99	4.13			
6 29	1,073	894.4	−5.1	0.73	100	4.00			
7 37	1,238	876.2	.6	−3.26	72	4.59			Inversion.
8 58	1,420	856.4	1.1	−.27	48	3.17			Inversion.
	1,500	848.0	.8		46	2.98			
10 36	1,635	833.8	.3	.37	43	2.68			
12 22	1,859	810.7	−.3	.27	30	1.79			
	2,000	796.5	−1.0		30	1.69			
14 53	2,233	773.6	−2.2	.51	30	1.53			
	2,500	747.9	−4.2		29	1.25			
18 16	2,628	735.9	−5.1	.73	28	1.12			
20 46	2,950	706.3	−6.7	.50	28	.98			
	3,000	703.1	−6.8		29	1.00			
22 05	3,215	682.7	−7.1	.15	34	1.15			
	4,000	616.3	−13.3		40	.78			
28 36	4,198	600.7	−14.9	.79	42	.71			
29 04	4,291	593.3	−15.0	.11	42	.70			
32 11	4,824	552.8	−18.9	.73	41	.48			
	5,000	539.8	−20.4		39	.39			
33 21	5,045	536.8	−20.8	.86	38	.37			
35 01	5,359	514.6	−23.7	.92	41	.30			Adiabatic.
	6,000	471.4	−29.4		46	.19			
41 34	6,352	448.6	−32.5	.89	48	.14			
	7,000	409.3	−38.3		48	.08			
46 01	7,097	403.0	−39.2	.90	48	.07			Adiabatic.

Launched 8:15 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Relative	Vapor pressure	Direction	Velocity	Remarks
0 00	229	994.9	0.7		81	5.20	sw.	1.8	10 St., W.
	500	961.5	−1.3		81	4.45			
	1,000	902.1	−5.1		81	3.24			
4 58	1,083	893.5	−5.7	0.75	81	3.08			
5 45	1,198	880.5	−.2	−4.78	61	3.67			Inversion.
7 08	1,459	852.3	1.0	−.46	42	2.76			Inversion.
	1,500	848.5	.8		42	2.72			
	2,000	797.0	−1.9		38	1.99			
	2,500	747.5	−4.5		34	1.43			
16 28	2,965	704.6	−7.0	.53	30	1.02			
	3,000	701.1	−7.0		28	.95			
18 07	3,285	676.3	−6.7	−.09	25	.87			Inversion.
	4,000	618.0	−11.1		28	.67			
25 19	4,614	569.0	−14.8	.61	30	.51			
	5,000	540.8	−17.8		31	.40			
28 28	5,196	526.6	−19.3	.77	32	.36			
31 54	5,937	476.9	−24.2	.66	27	.19			
	6,000	473.1	−24.7		27	.18			
	7,000	412.1	−32.4		27	.08			
40 30	7,606	377.5	−37.1	.77	27	.05			
	8,000	355.9	−39.9		27	.04			
	9,000	307.4	−47.0		26	.02			
49 35	9,596	281.6	−51.2	.71	25	.01			
	10,000	264.8	−53.0		25	.01			
52 14	10,150	259.1	−53.7	.45	25	.01			Tropopause.
54 55	10,710	237.6	−54.3	.11	25	.01			
	11,000	227.5	−52.0		25	.01			
58 29	11,206	220.6	−50.4	−.79	25	.01			
	12,000	195.7	−48.5		24	.01			
65 08	12,565	179.7	−47.1	−.24	23	.01			
	13,000	168.3	−47.1		23	.01			
69 55	13,480	156.7	−47.1	.00	23	.01			
	14,000	144.9	−49.8		23	.01			
75 07	14,545	133.6	−52.6	.52	22	.01			
	15,000	124.2	−52.8		21	.01			
79 40	15,317	118.5	−53.0	.05	20	(1)			
	16,000	107.1	−51.1		20	.01			
87 56	16,835	94.2	−48.8	−.28	20	.01			
	17,000	92.2	−48.6		20	.01			
	18,000	79.3	−47.4		22	.01			
95 50	18,765	70.4	−46.4	−.12	23	.01			
	19,000	68.3	−45.8		23	.02			
	20,000	59.4	−43.0		21	.02			
104 28	20,584	53.8	−41.4	−27	20	.02			

[1] Less than 0.01 mb,

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

CINCINNATI, OHIO—Continued

Launched 2:09 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
0 00	229	933.2	1.2		80	5.33	SW.	2.2	10 St. SW.
	500	960.5	−1.2		87	4.81			
2 06	937	908.7	−5.1	0.89	98	3.92			
	1,000	902.2	−4.1		91	3.96			
3 10	1,247	873.9	−0.3	−1.55	65	3.87			Inversion.
	1,500	846.5	−1.5		61	3.29			
	2,000	794.8	−3.9		54	2.39			
	2,500	746.5	−6.4		46	1.65			
	3,000	700.2	−8.8		39	1.13			
12 28	3,218	679.9	−9.8	.48	36	.96			
14 34	3,607	646.9	−8.3	−.39	31	.94			Inversion.
15 54	3,875	624.7	−11.3	1.12	29	.68			Superadiabatic.
	4,000	614.9	−12.1		30	.65			
19 40	4,649	564.2	−16.1	.62	36	.54			
	5,000	540.1	−17.2		32	.44			
21 30	5,055	534.7	−17.4	.32	31	.42			
	6,000	471.6	−24.7		31	.20			
30 00	6,787	421.9	−30.8	.77	31	.11			
	7,000	408.9	−32.7		31	.09			
	8,000	355.3	−41.9		31	.03			
38 06	8,273	341.4	−44.4	.92	31	.02			Adiabatic.
	9,000	306.4	−47.9		30	.02			
45 10	9,755	273.7	−51.6	.49	28	.01			Tropopause.
	10,000	263.7	−51.5		28	.01			
	11,000	226.3	−51.0		27	.01			
53 46	11,670	204.5	−50.7	−.05	27	.01			
	12,000	194.9	−50.3		27	.01			
	13,000	168.0	−49.1		27	.01			
62 05	13,380	158.0	−48.6	−.12	27	.01			
	14,000	144.4	−49.0		27	.01			
	15,000	124.0	−49.8		27	.01			
71 35	15,769	110.2	−50.3	.07	27	.01			
	16,000	106.8	−50.3		27	.01			
	17,000	91.8	−50.4		27	.01			
	18,000	78.9	−50.5		27	.01			
80 20	18,273	75.4	−50.5	.01	27	.01			
	19,000	67.8	−49.4		27	.01			
	20,000	58.2	−47.9		27	.01			
88 11	20,135	56.9	−47.7	−.15	27	.01			
	21,000	50.1	−45.2		27	.02			
	22,000	42.9	−42.3		27	.03			
95 10	22,321	40.1	−41.4	−.29	27	.03			

CONCORDIA, KANS.

Launched 2:15 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Relative	Vapor pressure	Direction	Velocity	Remarks
0 00	418	965.9	1.9		63	4.41	w.	2.7	8 A St., W.
	500	955.6	3.2		63	4.84			
1 24	706	932.2	6.6	−1.63	62	6.04			Inversion.
	1,000	899.4	4.8		62	5.33			
	1,500	845.6	1.7		62	4.28			
8 58	1,965	798.0	−1.1	.61	62	3.46			
	2,000	794.0	−1.4		62	3.37			
	2,500	745.0	−5.0		63	2.54			
13 53	2,846	713.6	−7.6	.74	63	2.03			
	3,000	700.0	−9.1		64	1.81			
17 01	3,490	656.3	−13.8	.96	69	1.28			Adiabatic.
	4,000	614.3	−18.0		74	.93			
21 34	4,331	586.9	−20.7	.82	78	.76			
22 14	4,439	578.6	−20.9	.19	81	.78			
	5,000	536.2	−25.4		86	.53			
	6,000	466.8	−33.5		95	.25			
29 48	6,044	463.7	−33.8	.80	95	.24			
	7,000	404.4	−42.6		96	.09			
35 35	7,277	388.1	−45.2	.92	96	.07			Adiabatic.
	8,000	348.0	−52.3		96	.02			
41 18	8,135	340.6	−53.6	.98	96	.02			Adiabatic.

Launched 7:56 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Relative	Vapor pressure	Direction	Velocity	Remarks
0 00	418	973.0	0.8		35	2.26	w.	1.3	Cloudless.
	500	962.8	2.5						
1 37	619	949.1	4.9	−2.04					Inversion.
	1,000	904.6	2.8						
6 18	1,075	897.1	2.4	.55					
	1,500	851.5	−1.1						
13 17	1,886	810.4	−4.3	.83					
	2,000	800.4	−4.7						
	2,500	751.3	−6.2						
21 21	2,602	739.9	−6.5	.31					
	3,000	703.7	−7.9						
28 41	3,224	683.2	−8.7	.35					
36 59	3,956	621.1	−13.2	.61					
	4,000	619.2	−13.4						
45 15	4,661	566.1	−16.1	.41					
	5,000	540.5	−17.9						
53 21	5,369	514.8	−19.9	.54					
	6,000	473.4	−23.3						
61 43	6,179	461.1	−24.3	.54					
71 13	6,976	413.3	−31.0	.84					

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

DAVENPORT, IOWA

Launched 8:16 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
0 00	178	991.2	−0.6		88	5.11	ssw.	6.7	Few A. Cu. W.; 9 A St., W.
1 03	352	969.6	−.9	0.17	94	5.33	sw.	10.4	
	500	951.5	−.9		90	5.10	wsw.	11.6	
3 32	809	915.2	−.8	−.02	83	4.75	w.	10.7	Inversion.
	1,000	893.9	.3		69	4.31	w.	11.2	
5 16	1,078	885.8	.7	−.56	64	4.11	w.	14.4	Inversion.
7 10	1,386	852.3	−.6	.42	74	4.30	w.	19.1	
	1,500	840.0	−1.2		73	4.04	w.	18.0	
9 46	1,878	801.2	−3.1	.51	69	3.26	w.	16.7	
	2,000	787.8	−4.1		69	3.00	w.	15.8	
	2,500	739.7	−8.0		72	2.25	wsw.	17.7	
15 01	2,857	706.7	−10.8	.79	73	1.78	wsw.	18.8	
	3,000	693.4	−11.6		74	1.68			
	4,000	611.4	−17.5		78	1.03			
	5,000	532.3	−23.4		82	.62			
25 22	5,034	529.1	−23.6	.59	82	.60			
	6,000	458.6	−30.6		78	.28			
	7,000	400.5	−37.9		74	.12			
34 14	7,316	384.2	−40.2	.73	73	.09			

Launched 2:04 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	178	989.8	3.0		69	5.23	wnw.	6.7	1 Ci. St., W.; 8 St. Cu., WNW.
	500	951.1	−.7		84	4.85	wnw.	7.2	
3 40	759	920.5	−3.6	1.14	96	4.36			Superadiabatic.
4 22	943	899.2	−2.7	−.49	73	3.57			Inversion.
	1,000	892.3	−3.1		73	3.45			
	1,500	838.6	−6.2		69	2.51			
	2,000	787.4	−9.4		66	1.82			
	2,500	738.0	−12.6		62	1.29			
	3,000	690.0	−15.7		59	.93			
13 42	3,087	681.6	−16.3	.63	58	.86			
	4,000	604.2	−23.4		62	.46			
	5,000	525.7	−31.2		67	.23			
22 24	5,222	509.0	−32.9	.78	68	.19			
	6,000	456.3	−38.8		68	.10			
	7,000	394.2	−46.3		68	.04			
30 04	7,792	349.2	−52.3	.76	68	.02			Tropopause.
	8,000	339.0	−52.1		67	.02			
	9,000	291.6	−51.1		61	.02			
37 16	9,932	252.2	−50.2	−.10	56	.02			
	10,000	250.6	−49.9		56	.02			
	11,000	215.0	−45.5		54	.04			
43 02	11,715	193.3	−42.3	−.44	53	.05			
	12,000	184.7	−42.8		52	.05			
	13,000	159.4	−44.6		49	.04			
52 02	13,523	147.8	−45.5	.18	48	.03			
	14,000	137.5	−45.6		48	.03			
59 08	14,770	122.9	−45.7	.02	48	.03			
	15,000	118.8	−46.2		48	.03			
	16,000	102.3	−48.1		48	.02			
67 08	16,293	97.6	−48.7	.20	48	.02			

Launched 2:05 a.m. Dec. 29, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	178	994.6	−1.0		80	4.50	nw.	4.9	1 St. Cu., NW.
	500	955.2	−3.3		88	4.09	nw.	10.9	
4 04	815	917.6	−5.6	0.72	96	3.68	nw.	18.2	
	1,000	895.6	−7.5		97	3.16	nw.	21.0	
8 29	1,314	860.6	−10.6	1.00	100	2.48	nw.	18.7	Adiabatic.
9 07	1,436	847.0	−7.2	−2.79	96	3.21			Inversion.
	1,500	839.5	−7.5		95	3.10			
	2,000	786.1	−10.1		85	2.21			
	2,500	736.2	−12.8		76	1.55			
18 47	2,735	715.5	−14.0	.52	71	1.30			
	3,000	689.9	−16.0		67	1.02			
28 14	3,946	608.3	−23.0	.74	55	.43			
	4,000	603.3	−23.1		55	.43			
29 38	4,129	593.6	−23.2	.11	55	.42			
	5,000	525.8	−28.8		55	.24			
37 59	5,157	514.8	−29.8	.64	55	.22			
	6,000	457.5	−35.7		57	.12			
46 40	6,295	438.0	−37.7	.69	58	.10			
	7,000	396.8	−43.9		56	.05			
57 29	7,624	360.2	−49.4	.88	55	.02			

DENVER, COLO.

Launched 1:49 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	1,620	839.8	4.2		19	1.57	nw.	5.4	Cloudless.
	2,000	801.4	1.7		19	1.31			
	2,500	753.3	−1.5		20	1.08			
7 08	2,794	725.3	−3.4	0.65	20	.92			
	3,000	706.2	−5.0		21	.85			
	4,000	621.7	−12.7		24	.49			
16 27	4,693	567.0	−18.1	.77	27	.34			
	5,000	544.5	−19.8		27	.29			

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

DENVER, COLO.—Continued

Launched 1:49 a.m. Dec. 18, 1929 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
19 13	5,083	537.7	−20.2	0.54	27	.28			
21 25	5,428	513.5	−20.2	.00	27	.28			Isothermal.
	6,000	475.1	−25.1		28	.18			
26 12	6,435	447.5	−28.9	.86	28	.12			
	7,000	412.6	−33.8		29	.07			
30 14	7,379	391.2	−37.1	.87	29	.05			

Launched 1:43 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	1,620	841.8	7.7		26	2.73	n.	3.6	8 A. Cu., N.
	2,000	803.2	4.1		39	3.19	nw.	9.3	
2 12	2,226	781.4	1.9	0.96	47	3.29	wnw.	12.5	Adiabatic.
	2,500	754.7	−.1		49	2.97	wnw.	15.7	
	3,000	708.1	−3.8		52	2.32	wnw.	19.9	
9 54	3,745	644.9	−9.3	.74	57	1.58	nw.	15.7	
	4,000	621.8	−11.3						
16 43	4,864	556.7	−17.9	.77					
	5,000	546.7	−18.2						
22 20	5,850	487.8	−20.3	.24					
	6,000	478.3	−22.0						
	7,000	415.4	−33.1						
29 40	7,075	411.6	−33.9	1.11					Superadiabatic.
	8,000	360.3	−41.4						
36 41	8,504	334.8	−45.5	.81					
	9,000	311.1	−48.7						
40 45	9,286	297.6	−50.6	.65					

Launched 7:46 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	1,620	841.3	6.4		31	2.98	s.	2.7	Cloudless.
	2,000	804.7	4.4		31	2.59	sw.	3.0	
	2,500	756.8	1.7		32	2.21	wnw.	4.7	
6 35	2,963	712.6	−.8	0.54	32	1.83	nw.	5.2	
	3,000	708.9	−1.0		32	1.80	nw.	5.4	
	4,000	623.3	−5.7		32	1.22	nnw.	8.1	
	5,000	549.5	−10.4		32	.81			
16 25	5,278	530.1	−11.7	.47	32	.72			
	6,000	482.0	−17.9		31	.39			
	7,000	421.0	−26.5		30	.16			
24 55	7,315	403.1	−29.1	.85	30	.13			
	8,000	366.2	−34.1		32	.08			
28 11	8,179	357.0	−35.4	.73	32	.07			

LITTLE ROCK, ARK.

Launched 7:57 a.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	127	1,008.1	1.2		97	6.46	nw.	1.8	Few Ci., W.; 10 Lt. Fog, NW.
0 52	286	988.5	3.5	−1.45	100	7.85			Inversion.
	500	959.6	3.4		91	7.09			
	1,000	902.2	3.0		69	5.23			
7 06	1,481	853.0	2.7	.07	48	3.56			Isothermal.
	1,500	851.0	2.6		48	3.53			
	2,000	800.1	.8		43	2.78			
	2,500	751.2	−1.1		37	2.06			
12 58	2,527	748.8	−1.2	.37	37	2.05			
	3,000	705.6	−1.8		33	1.74			
15 42	3,037	702.5	−1.8	.12	33	1.74			
	4,000	620.8	−8.0		32	1.00			
25 44	4,692	568.3	−12.5	.65	32	.67			
	5,000	545.0	−14.7		32	.55			
	6,000	477.4	−21.8		30	.26			
35 06	6,364	454.9	−24.4	.71	30	.20			
	7,000	417.1	−27.6		30	.15			
	8,000	361.9	−32.6		30	.09			
44 32	8,046	360.3	−32.8	.50	30	.09			
	9,000	313.5	−38.7		30	.04			
54 10	9,764	281.5	−43.5	.62	30	.03			

Launched 1:50 p.m. Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	127	1,006.9	11.0		63	8.27	sw.	2.7	Few Ci., W.
	500	964.0	8.6		64	7.15			
2 12	822	925.8	6.6	0.63	65	6.33			
	1,000	907.3	5.4		63	5.65			
	1,500	852.5	2.7		58	4.30			
	2,000	802.4	−.1		53	3.21			
	2,500	753.6	−3.0		48	2.29			
10 34	2,520	750.2	−3.1	.57	48	2.27			
	3,000	702.2	−5.1		45	1.80			
17 04	3,829	635.2	−8.6	.42	41	1.21			
	4,000	612.9	−9.8		41	1.09			
	5,000	543.2	−16.5		39	.57			
25 06	5,552	506.4	−20.2	.67	38	.39			
	6,000	478.5	−23.1		38	.29			
	7,000	415.9	−29.4		38	.16			
32 38	7,276	399.9	−31.2	.64	38	.13			
	8,000	360.8	−35.4		36	.08			

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

LITTLE ROCK, ARK.—Continued

Launched 1:50 p.m. Dec. 28, 1929 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
41 24	8,923	316.1	−40.5	0.56	33	.04			
	9,000	312.7	−40.9		33	.04			
	10,000	270.0	−46.5		33	.02			
45 32	10,093	266.9	−47.1	.56	33	.02			Tropopause.
46 44	10,306	258.3	−46.6	−.23	33	.02			
	11,000	232.6	−48.7		33	.02			
	12,000	200.0	−51.8		33	.01			
55 47	12,888	175.0	−54.6	.31	33	.01			
	13,000	171.8	−54.6		33	.01			
	14,000	147.5	−54.5		33	.01			
63 52	14,386	139.2	−54.4	−.01	33	.01			
	15,000	126.7	−56.1		33	.01			
	16,000	108.4	−58.9		33	(1)			
72 26	16,451	100.9	−60.2	.28	33	(1)			
	17,000	92.6	−59.2		33	(1)			
	18,000	79.0	−57.5		33	(1)			
	19,000	67.5	−55.7		33	.01			
83 29	19,349	64.1	−55.1	−.18	33	.01			
	20,000	57.7	−52.2		33	.01			
	21,000	49.5	−47.7		33	.02			
93 34	21,559	45.9	−45.2	−.45	33	.02			

[1] Less than 0.01 mb.

NASHVILLE, TENN.

Launched 2:01 a.m. Dec. 28, 1929 (75th mer.)

0 00	149	997.6	5.6		96	8.73	nw.	4.5	10 St. Cu., NW.
	500	953.9	3.1		96	7.32			
2 09	647	938.3	2.1	0.70	96	6.82			
3 09	952	903.8	4.6	−.82	92	7.80			Inversion.
	1,000	899.7	4.6		90	7.63			
4 47	1,329	863.0	4.4	.05	74	6.19			Isothermal.
	1,500	844.8	3.4		74	5.76			
	2,000	794.4	.5		76	4.81			
10 13	2,393	756.4	−1.8	.58	77	4.06			
	2,500	746.0	−2.4		71	3.56			
13 22	2,812	717.1	−4.0	.53	54	2.37			
14 21	2,980	702.3	−3.8	−.12	45	2.01			Inversion.
	3,000	699.2	−3.9		45	1.99			
	4,000	615.9	−10.8		41	1.00			
23 38	4,232	598.0	−12.4	.69	40	.85			
	5,000	540.5	−17.5		35	.46			
27 41	5,045	537.1	−17.8	.66	35	.45			
28 23	5,211	525.6	−17.8	.00	33	.43			Isothermal.
	6,000	474.2	−22.6		32	.26			
38 17	6,847	421.1	−27.8	.61	30	.14			
	7,000	412.2	−29.2		30	.13			
	8,000	357.5	−38.3		27	.04			
45 39	8,210	346.9	−40.2	.91	26	.03			Adiabatic.

Launched 8:07 a.m. Dec. 28, 1929 (75th mer.)

0 00	149	1,004.0	2.0		95	6.70	n.	2.7	10 St., N.
	500	958.4	−.8		95	5.43			
1 58	599	945.8	−1.6	0.80	95	5.09			
3 14	890	912.2	3.0	−1.58	91	6.90			Inversion.
	1,000	899.5	3.0		93	7.05			
4 05	1,106	888.3	3.0	.00	95	7.20			Isothermal.
4 43	1,235	874.2	4.1	−.85	55	4.50			Inversion.
	1,500	845.2	3.3		51	3.95			
	2,000	794.5	1.7		44	3.04			
	2,500	746.8	.1		36	2.21			
10 16	2,510	745.5	.1	.31	36	2.21			
	3,000	700.5	−2.2		34	1.73			
16 29	3,839	631.4	−6.2	.47	31	1.13			
	4,000	618.1	−7.4		31	1.02			
	5,000	541.6	−14.5		29	.51			
25 14	5,887	483.2	−20.9	.72	27	.26			
	6,000	475.6	−21.7		27	.24			
	7,000	414.6	−28.4		26	.12			
33 37	7,899	365.8	−34.4	.67	26	.06			
	8,000	360.8	−35.1		26	.06			
	9,000	313.3	−41.8		26	.03			
40 28	9,561	287.7	−45.5	.67	26	.02			

Launched 1:55 p.m. Dec. 28, 1929 (75th mer.)

0 00	149	999.3	2.9		86	6.47	sw.	2.7	10 St. Cu. W.
2 46	500	956.5	.8	0.85	90	5.82			
4 04	647	939.3	−.1	.00	91	5.51			Isothermal.
5 25	868	913.9	4.1	−1.90	71	5.81			Inversion.
	1,000	897.5	3.7		68	5.41			
	1,500	842.3	2.1		57	4.05			
	2,000	793.9	.6		46	3.16			
13 56	2,065	788.0	.4	.31	45	2.83			
16 52	2,433	752.6	−.1	.14	40	2.42			
	2,500	746.5	−.6		40	2.32			
18 10	2,648	732.7	−1.7	.74	40	2.12			
	3,000	700.6	−1.9		34	1.78			

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

NASHVILLE, TENN.—Continued

Launched 1:55 p.m. Dec. 28, 1929 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
22 35	3,285	676.7	−2.0	0.05	30	1.55			Isothermal.
	4,000	617.5	−7.1		30	1.01			
33 21	4,886	550.6	−13.5	.72	30	.58			
	5,000	542.2	−13.7		30	.56			
34 16	5,032	540.3	−13.8	.21	30	.56			
39 53	5,973	476.7	−21.4	.81	30	.27			
	6,000	475.6	−21.6		30	.27			
45 48	6,944	417.3	−27.4	.62	30	.15			
	7,000	414.2	−27.7		30	.15			
	8,000	360.3	−33.5		30	.08			
55 37	8,525	334.6	−36.1	.55	30	.06			
	9,000	312.6	−39.6		30	.04			
62 19	9,610	286.3	−44.1	.74	30	.02			
	10,000	270.0	−46.5		30	.02			
68 08	10,684	243.7	−50.7	.61	30	.01			Tropopause.
	11,000	232.4	−50.7		29	.01			
	12,000	199.4	−50.6		26	.01			
77 46	12,456	186.5	−50.5	−.01	25	.01			
	13,000	171.6	−50.6		25	.01			
	14,000	147.3	−50.9		24	.01			
87 50	14,327	140.6	−51.0	.03	24	.01			
91 38	14,969	127.5	−54.7	.58	24	(1)			
	15,000	126.9	−54.7		24	(1)			
	16,000	108.8	−55.7		24	(1)			
102 05	16,690	97.9	−56.3	.09	24	(1)			
	17,000	93.5	−56.1		24	(1)			
	18,000	79.7	−55.6		24	(1)			
108 01	18,025	79.6	−55.6	−.05	24	(1)			

[1] Less than 0.01 mb.

Launched 8:02 p.m., Dec. 28, 1929 (75th mer.)

0 00	149	998.3	2.0		87	6.13	s.	1.8	Cloudless.
1 13	305	979.3	6.7	−3.01	79	7.75			Inversion.
	500	954.9	5.6		79	7.18			
5 00	757	926.6	4.2	.51	79	6.52			
6 31	910	909.5	5.1	−.59	58	5.09			Inversion.
	1,000	899.4	4.4		57	4.76			
	1,500	845.1	.6		54	3.45			
	2,000	794.5	−3.2		51	2.39			
16 07	2,178	776.4	−4.6	.76	50	2.08			
	2,500	745.1	−6.9		52	1.78			
18 59	2,592	736.5	−7.5	.70	53	1.73			
	3,000	699.1	−10.7		69	1.70			
24 31	3,376	665.4	−13.7	.79	83	1.56			
27 48	3,789	630.3	−15.1	.34	74	1.22			
29 19	4,003	612.8	−13.1	−.93	59	1.17			Inversion.
	5,000	537.0	−19.5		58	.64			
38 57	5,398	508.8	−22.0	.64	57	.49			
	6,000	469.5	−26.5		57	.31			
46 42	6,789	420.0	−32.4	.75	58	.17			
	7,000	407.6	−33.8		57	.15			
	8,000	352.7	−40.4		53	.06			
55 52	8,414	332.6	−43.1	.66	51	.05			

ST. LOUIS, MO.

Launched 8 a.m., Dec. 28, 1929 (75th mer.)

0 00	170	999.0	−2.6		99	4.88	s.	3.1	10 Lt. fog; 10 Lt. smoke.
1 39	486	960.2	1.3	−1.23	99	6.64	wsw.	7.7	Inversion.
	500	958.0	1.4		98	6.62	wsw.	7.8	
3 55	934	908.5	3.5	−.49	58	4.55	w.	12.8	Inversion.
	1,000	901.3	3.0		58	4.40	w.	12.8	
	1,500	845.9	−0.9		61	3.46	w.	13.8	
	2,000	792.6	−4.6		64	2.67	wnw.	12.5	
	2,500	744.9	−8.4		67	2.02	wnw.	12.4	
13 49	2,736	723.4	−10.2	.76	68	1.75	wnw.	12.5	
	3,000	696.0	−10.7		63	1.55	wnw.	15.6	
17 23	3,318	671.0	−11.2	.17	58	1.36			
19 45	3,718	636.8	−13.2	.50	65	1.28			
	4,000	613.5	−14.3		61	1.09			
23 46	4,558	570.1	−16.5	.39	53	.77			
	5,000	536.7	−20.4		54	.54			
	6,000	468.7	−29.1		56	.24			
31 04	6,083	463.0	−29.8	.87	56	.22			
	7,000	407.4	−37.0		54	.10			
38 01	7,734	365.9	−42.8	.79	53	.05			

SIOUX CITY, IOWA

Launched 8:25 p.m., Dec. 28, 1929 (75th mer.)

0 00	361	977.7	0.9		53	3.46	w.	2.7	Few A St., W.
	500	960.0	.5		52	3.29			
1 46	530	955.0	.5	0.24	52	3.29			
	1,000	903.0	−2.5		58	2.88			

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

SIOUX CITY, IOWA—Continued

Launched 8:25 p.m., Dec. 28, 1929 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
5 20	1,410	859.0	−5.2	0.65	62	2.46			
	1,500	848.0	−5.7		61	2.32			
	2,000	795.0	−8.6		59	1.75			
	2,500	742.0	−11.4		55	1.27			
11 59	2,860	710.0	−13.3	.56	52	1.01			
	3,000	696.0	−14.0		51	.93			
	4,000	608.0	−19.0		49	.56			
22 11	4,960	537.0	−23.2	.47	47	.36			
	5,000	533.0	−23.5		47	.35			
	6,000	463.0	−30.0		47	.18			
	7,000	402.0	−36.5		47	.09			
31 58	7,290	386.0	−38.3	.65	47	.07			
	8,000	347.0	−43.8		48	.04			
37 30	8,620	317.0	−48.6	.77	48	.02			

Launched 1:56 a.m., Dec. 29, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	361	975.3	−1.1		68	3.79	s.	3.6	Few A. St., W.
	500	959.0	−1.1		66	3.70			
1 55	806	923.0	−1.1	0.00	62	3.46			Isothermal.
	1,000	901.0	−2.3		63	3.10			
	1,500	843.0	−5.9		66	2.50			
7 56	2,000	793.0	−9.5	.70	68	1.86			
8 46	2,180	772.0	−9.1	−.22	68	1.92			Inversion.
	2,500	742.0	−10.0		70	1.85			
	3,000	695.0	−11.3		73	1.70			
16 07	3,810	622.0	−13.7	.28	75	1.41			
	4,000	608.0	−15.4		78	1.40			
	5,000	531.0	−23.8		80	.90			
	6,000	463.0	−32.6		83	.40			
25 46	6,180	451.0	−34.2	.86	83	.20			
	7,000	402.0	−40.9		80	.10			
	8,000	347.0	−49.1		75	.03			
33 22	8,070	343.0	−49.9	.83	75	.03			
	9,000	296.0	−57.1		73	.01			
40 22	9,790	262.0	−63.7	.80	71	(1)			Tropopause.
	10,000	253.0	−63.5		71	(1)			
	11,000	216.0	−62.8		71	(1)			
	12,000	184.0	−62.0		70	(1)			
50 05	12,260	176.0	−61.7	−.08	70	.01			
	13,000	156.0	−62.2		70	(1)			
	14,000	132.0	−62.8		70	(1)			
59 35	14,400	124.0	−63.2	.07	70	(1)			
	15,000	112.0	−63.2		70	(1)			
	16,000	96.0	−63.5		70	(1)			
69 22	16,730	85.0	−63.5	.01	70	(1)			
	17,000	81.0	−63.5		70	(1)			
	18,000	69.0	−63.4		70	(1)			
79 16	18,510	64.0	−63.3	−.01	70	(1)			
	19,000	59.0	−64.0		69	(1)			
85 56	19,530	54.0	−65.0	.17	68	(1)			

[1] Less than 0.01 mb.

VICKSBURG, MISS.

Launched 8 a.m., Dec. 28, 1929 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	92	1,011.7	7.8		99	10.47	nw.	2.2	10 Nb., NW.; 10 Lt. fog, NW.
	500	962.5	6.2		100	9.48			
1 19	638	946.9	5.6	0.40	100	9.09			
	1,000	906.8	7.5		92	9.54			
3 32	1,121	892.9	8.2	−.54	89	9.67			Inversion.
5 26	1,446	858.4	7.3	.28	89	9.10			
	1,500	853.0	7.1		87	8.78			
	2,000	802.3	5.5		66	5.96			
	2,500	755.1	3.8		45	3.61			
13 14	2,777	729.3	2.9	.33	33	2.48			
	3,000	709.4	1.4		30	2.03			
16 36	3,283	685.0	−.5	.67	27	1.58			
17 32	3,395	675.6	−.3	−.18	26	1.55			Inversion.
19 11	3,649	654.4	.8	−.43	22	1.42			Inversion.
	4,000	626.5	−.9		20	1.13			
26 13	4,580	582.3	−3.7	.48	18	.81			
	5,000	553.4	−6.8		18	.62			
33 01	5,526	516.0	−10.6	.73	17	.42			
	6,000	485.6	−14.1		16	.29			
39 44	6,386	461.0	−17.0	.74	15	.21			

AMARILLO, TEX.

Launched 2 a.m., Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	1,117	886.1	−6.8		47	1.63	ne.	4.0	10 St., NE.
1 38	1,420	851.0	−9.7	0.97	68	1.83			Adiabatic.
	1,500	843.0	−7.5		65	2.12			
	2,000	792.0	3.6		50	3.95			
3 55	2,230	769.0	8.5	−2.24	41	4.55			Inversion.
	2,500	742.0	6.6		42	4.09			
	3,000	699.0	3.2		42	3.23			

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

AMARILLO, TEX.—Continued

Launched 2 a.m., Jan. 7, 1930 75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
7 47	3,210	680.0	1.9	0.67	43	3.01			
	4,000	614.0	−5.4		54	2.11			
14 19	4,730	560.0	−12.1	.92	63	1.37			
	5,000	540.0	−13.8		59	1.10			
17 29	5,470	507.0	−16.8	.63	47	.66			
	6,000	472.0	−21.6		41	.37			
21 20	6,300	451.0	−24.3	.90	39	.27			
	7,000	411.0	−29.3		37	.15			
27 49	7,970	357.0	−36.5	.73	34	.06			
	8,000	356.0	−36.6		34	.06			
	9,000	306.0	−47.0		36	.02			
35 50	9,770	272.0	−55.2	1.04	39	.01			Superadiabatic.

CINCINNATI, OHIO

Launched 8:03 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	229	998.3	14.4		56	9.19	sse.	6.3	10 St. Cu.,
	500	968.2	13.1						
	1,000	914.0	10.6						
	1,500	857.8	8.1						
4 56	1,517	855.5	8.0	0.50					
	2,000	806.9	5.3						
8 09	2,276	779.9	3.8	.55					
	2,500	759.6	2.3						
	3,000	713.7	−1.1						
11 10	3,125	701.9	−1.9	.67					
	4,000	626.5	−7.5						
	5,000	550.8	−13.8						
20 15	5,166	539.9	−14.9	.64					
21 03	5,388	527.8	−14.0	−.52					Inversion.
	6,000	485.1	−18.0						
27 39	6,863	431.0	−23.3	.61					
	7,000	423.2	−24.5						
	8,000	368.1	−33.3						
36 10	8,708	332.7	−39.0	.88					
	9,000	318.8	−41.6						
	10,000	274.9	−50.4						
43 34	10,746	246.1	−57.0	.88					

Launched 2:05 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	229	997.3	13.7		62	9.72	s.	8.0	10 St. Cu., S.
	500	966.0	13.0		63	9.44			
	1,000	910.0	11.7		66	9.08			
3 38	1,138	894.9	11.3	0.26	67	8.97			
	1,500	857.6	9.3		66	7.73			
	2,000	807.8	6.4		66	6.34			
11 19	2,415	766.5	4.1	.56	65	5.32			
	2,500	759.5	3.6		65	5.14			
	3,000	715.0	0.9		66	4.30			
19 30	3,652	657.1	−2.7	.55	67	3.28			
	4,000	630.0	−4.8		69	2.83			
	5,000	553.4	−10.7		75	1.84			
28 49	5,279	533.8	−12.3	.59	77	1.64			
	6,000	485.9	−17.2		77	1.05			
	7,000	424.6	−24.0		77	.54			
38 05	7,343	404.8	−26.3	.68	77	.43			
	8,000	370.4	−30.9						
	9,000	321.3	−37.9						
46 08	9,195	312.1	−39.3	.70					
	10,000	278.2	−45.4						
	11,000	240.0	−53.0						
55 09	11,093	236.2	−53.7	.76					
	12,000	205.6	−61.9						
64 28	12,875	178.6	−69.9	.91					Tropopause.
	13,000	175.2	−69.0						
	14,000	149.4	−62.0						
70 59	14,036	148.2	−61.7	−.71					
	15,000	127.3	−63.5						
80 43	15,982	109.0	−65.3	.18					
	16,000	108.6	−65.3						
	17,000	92.7	−66.9						
90 15	17,650	83.2	−67.9	.16					
	18,000	79.0	−68.3						
96 29	18,418	73.5	−68.7	.10					
102 31	18,896	68.0	−68.3	−.08					

Launched 2:12 p.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	229	997.2	12.1		96	13.56	sw.	4.0	10 Nb., SW.
	500	964.3	10.8		96	12.43			
	1,000	908.2	8.3		96	10.51			
5 11	1,038	905.0	8.1	0.49	96	10.37			
	1,500	856.0	6.6		96	9.35			
8 46	1,641	841.0	6.2	.32	96	9.10			
	2,000	805.7	4.4		95	7.94			
	2,500	757.7	2.0		95	6.70			
16 28	2,952	715.5	−.2	.49	94	5.65			
	3,000	710.9	−.2		94	5.65			
19 29	3,115	701.3	−.2	.00	94	5.65			Isothermal.

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

CONCORDIA, KANS.

Launched 2:03 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
0 00	418	966.8	−6.8		40	1.38	n.	5.8	3A St. NW.; 4 St. Cu., NW.
	500	956.1	−8.6		43	1.27			
2 12	588	945.8	−10.5	2.18	47	1.18			Superadiabatic.
2 44	629	940.7	−10.6	.24	22	.55			
3 42	761	924.8	−11.8	.91	22	.49			Adiabatic.
	1,000	896.5	−14.8		15	.26			
6 38	1,014	894.4	−15.0	1.26	15	.25			Superadiabatic.
7 17	1,131	880.8	−14.6	−.34	15	.26			Inversion.
8 22	1,312	860.3	−6.5	−4.48	15	.53			Inversion.
	1,500	838.8	−2.8		15	.73			
9 38	1,567	833.0	−1.4	−2.00	15	.82			Inversion.
11 35	1,807	808.2	.3	−.71	15	.94			Inversion.
12 13	1,953	793.5	2.1	−1.23	15	1.06			Inversion.
	2,000	788.9	2.4		15	1.09			
13 40	2,116	777.9	3.1	−.61	15	1.14			Inversion.
15 29	2,433	748.0	3.8	−.22	15	1.20			Inversion.
	2,500	741.7	3.2		15	1.15			
	3,000	697.2	−.9		15	.85			
23 57	3,727	635.7	−7.0	.83	15	.51			
	4,000	614.7	−8.9		15	.43			
	5,000	539.5	−16.1		13	.20			
32 17	5,386	511.4	−18.8	.71	12	.14			
	6,000	471.6	−23.0		12	.09			
40 19	6,976	411.7	−29.6	.68	12	.05			
	7,000	410.3	−29.8		12	.05			
	8,000	356.7	−36.7		12	.02			
48 10	8,954	312.0	−40.7	.56	12	.01			

Launched 2:09 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Relative humidity	Vapor pressure	Wind direction	Wind velocity	Remarks
0 00	418	975.3	−14.5		36	0.63	n.	3.1	Cloudless.
	500	963.6	−15.2		36	.59			
	1,000	901.0	−19.4		37	.41			
3 16	1,032	898.5	−19.7	0.85	37	.40			
4 58	1,313	865.9	−8.9	−3.84	35	1.01			Inversion.
	1,500	843.4	−5.5		35	1.35			
6 55	1,559	838.9	−4.4	−1.83	35	1.48			Inversion.
8 41	1,933	800.1	−4.4	.00	33	1.40			Isothermal.
	2,000	793.1	−4.7		33	1.37			
	2,500	745.3	−6.8		34	1.18			
13 33	2,912	706.0	−8.6	.43	35	1.04			
	3,000	697.8	−8.8		36	1.05			
14 52	3,167	682.9	−9.1	.20	38	1.08			
	4,000	611.4	−14.2		43	.77			
20 57	4,315	587.4	−16.2	.62	45	.67			
	5,000	535.6	−21.5		45	.41			
27 05	5,781	481.6	−27.5	.77	44	.22			
	6,000	468.1	−28.0		42	.20			
28 03	6,051	464.1	−28.1	.22	42	.20			
	7,000	407.7	−35.1		40	.09			
35 15	7,788	362.3	−40.9	.74	39	.04			
	8,000	351.9	−42.7		39	.04			
39 47	8,732	315.2	−49.0	.86	38	.02			

(Launched 8:09 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Relative humidity	Vapor pressure	Wind direction	Wind velocity	Remarks
0 00	418	975.8	−16.5		40	0.58	ne.	2.7	Few A. St., SW.; 1 A. Cu., SW.; few Cu., SW.
0 41	471	968.9	−16.5	0.00	41	.59			Isothermal.
	500	963.6	−16.8		41	.58			
2 58	973	905.6	−21.6	1.02	43	.38			Superadiabatic.
	1,000	903.3	−20.9		43	.41			
	1,500	846.5	−8.6		43	1.27			
6 09	1,685	825.1	−4.1	−2.46	43	1.87			Inversion.
	2,000	793.6	−3.9		40	1.77			
8 55	2,258	767.1	−3.7	−.07	38	1.71			Inversion.
9 47	2,412	752.6	−4.3	.39	41	1.75			
	2,500	744.0	−4.1		42	1.83			
	3,000	698.2	−3.1		49	2.32			
13 03	3,091	690.6	−2.9	−.21	50	2.40			Inversion.
	4,000	614.0	−12.5		69	1.45			
18 06	4,024	612.5	−12.8	1.06	70	1.43			Superadiabatic.
18 31	4,142	603.2	−12.1	−.59	60	1.30			Inversion.
	5,000	537.6	−18.9		48	.56			
25 09	5,221	522.4	−20.7	.80	45	.44			
	6,000	470.4	−23.7		43	.31			
34 54	6,683	428.0	−26.4	.39	41	.23			
	7,000	410.3	−27.2		40	.20			
	8,000	356.5	−29.7		39	.15			
44 25	8,547	330.1	−31.1	.25	38	.13			
	9,000	309.5	−31.9		38	.12			
	10,000	268.7	−33.6		39	.10			
54 20	10,487	250.9	−34.5	.18	39	.09			
	11,000	233.5	−35.7		38	.08			
59 02	11,408	219.9	−36.7	.24	38	.07			Tropopause.

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

CONCORDIA, KANS.—Continued

(Launched 8:09 a.m. Jan. 7, 1930 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
	12,000	202.8	−36.2		38	.08			
	13,000	176.3	−35.5		38	.08			
70 14	13,599	162.2	−35.0	−0.08	38	.09			
	14,000	153.2	−34.8		38	.09			
	15,000	133.0	−34.4		38	.09			
77 42	15,113	130.6	−34.3	−.05	38	.09			
	16,000	115.9	−34.7		38	.09			
85 28	16,945	100.7	−35.2	.05	38	.08			
	17,000	100.5	−35.2		38	.08			
	18,000	87.1	−35.1		38	.08			
92 37	18,386	82.0	−35.0	−.01	38	.09			

DAVENPORT, IOWA

Launched 8:09 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Relative humidity	Vapor pressure	Wind direction	Wind velocity	Remarks
0 00	178	1,000.7	−15.6		86	1.36	nw.	4.9	1 Ci. St., W.
	500	958.8	−18.9		92	1.07	nnw.	7.7	
1 52	695	933.7	−20.9	1.02	96	.96	nnw.	8.8	Superadiabatic.
	1,000	896.4	−9.8		80	2.14	nnw.	8.0	
3 32	1,188	875.7	−2.9	−3.65	70	3.37	nnw.	7.8	Inversion.
	1,500	842.1	−1.7		64	3.40	wnw.	7.6	
4 56	1,583	833.2	−1.4	−.38	62	3.37	wnw.	7.6	Inversion.
5 39	1,828	807.8	−2.9	.61	58	2.79	wsw.	7.5	
	2,000	790.2	−2.3		58	2.93	wsw.	6.3	
6 15	2,081	782.6	−2.0	−.36	58	3.00	wsw.	6.0	Inversion.
	2,500	743.2	−4.5		58	2.44	wsw.	8.4	
	3,000	698.3	−7.4		58	1.91	wsw.	13.2	
	4,000	612.4	−13.2		58	1.14	wsw.	29.2	
15 06	4,730	555.3	−17.5	.59	58	.77	sw.	34.2	
	5,000	535.2	−19.7		56	.60	sw.	34.3	
	6,000	467.1	−27.6		49	.24	sw.	47.1	
21 09	6,157	456.9	−28.9	.80	48	.21	wsw.	47.0	
	7,000	405.5	−36.0		48	.10			
26 10	7,277	389.9	−38.4	.85	48	.07			
	8,000	350.0	−44.2		49	.04			
33 02	8,859	308.7	−51.2	.81	51	.02			
	9,000	302.2	−52.0		51	.02			
	10,000	259.3	−57.8		51	.01			
40 26	10,559	237.4	−61.1	.58	51	(1)			

1 Less than 0.01 mb.

DENVER, COLO.

Launched 1:43 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Relative humidity	Vapor pressure	Wind direction	Wind velocity	Remarks
0 00	1,620	829.7	−0.8		44	2.52	ne.	3.6	9 St. Cu., W.
	2,000	791.4	−.8				e.	4.6	
2 32	2,012	789.8	−.8	0.00			e.	4.6	Isothermal.
	2,500	747.5	−3.5				nw.	.6	
5 11	2,520	740.9	−3.6	.55			nnw.	1.4	
6 16	2,800	715.1	−3.4	−.07			nnw.	1.6	Inversion.
	3,000	697.0	−5.0				wsw.	2.5	
	4,000	612.5	−13.1				wsw.	17.0	
16 04	4,563	568.9	−17.7	.81			wsw.	24.2	
17 28	4,881	544.9	−20.0	.72			wsw.	25.9	
	5,000	536.0	−20.1				wsw.	25.2	
19 01	5,153	525.5	−20.3	.11			wsw.	25.1	
21 32	5,477	503.1	−22.1	.56			wsw.	30.8	
	6,000	467.4	−27.0				sw.	32.4	
	7,000	405.6	−36.4				sw.	32.2	
29 54	7,198	395.2	−38.4	.95			sw.	32.2	Adiabatic.
	8,000	351.4	−45.1				sw.	26.6	
36 30	8,624	320.5	−50.3	.83					Tropopause.
	9,000	303.1	−50.8						
39 30	9,206	293.1	−51.1	.14					
	10,000	261.2	−47.9						
	11,000	224.7	−43.8						
49 41	11,175	218.7	−43.1	−.41					

Launched 1:51 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Relative humidity	Vapor pressure	Wind direction	Wind velocity	Remarks
0 00	1,620	831.9	−8.2		83	2.55	n.	2.2	10 St., N.
1 20	1,752	817.8	−10.9	2.05					Superadiabatic.
	2,000	790.9	−11.0						
4 14	2,110	780.6	−11.0	.03					Isothermal.
	2,500	740.2	−13.4						
	3,000	692.5	−16.5						
11 37	3,246	671.9	−18.0	.62					
	4,000	606.5	−18.2						
17 49	4,220	589.8	−18.3	.03					Isothermal.

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

LITTLE ROCK, ARK.

Launched 8:04 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m.s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
0 00	127	1,003.5	16.2		81	14.92	se.	3.6	10 St., SE.
1 03	414	970.1	14.8	0.49	95	16.00			
	500	959.9	15.0		94	16.04			
1 47	642	944.5	15.2	−.18	93	16.07			Inversion.
	1,000	906.0	13.0		94	14.08			
	1,500	851.6	9.9		96	11.71			
	2,000	802.5	6.8		98	9.68			
11 39	2,424	762.3	4.1	.62	100	8.19			
	2,500	755.4	3.9		100	8.07			
13 14	2,632	743.2	3.6	.24	100	7.90			
	3,000	710.0	.8		100	6.47			
15 44	3,053	705.3	.4	.76	100	6.29			
16 23	3,212	691.6	.6	−.13	76	4.85			Inversion.
20 39	3,887	635.4	−4.0	.68	96	4.21			
	4,000	627.6	−4.9		93	3.79			
24 27	4,471	590.0	−8.8	.82	80	2.33			
27 58	4,997	551.0	−13.2	.84	90	1.77			
28 55	5,179	538.2	−14.2	.55	58	1.04			
29 38	5,381	524.3	−13.7	−.25	42	.79			Inversion.
	6,000	482.7	−18.4		51	.62			
37 19	6,830	431.9	−24.8	.77	63	.41			
	7,000	422.3	−26.2		64	.36			
	8,000	367.8	−34.7		67	.16			
46 21	8,361	349.2	−37.7	.84	68	.11			
	9,000	318.3	−42.7		65	.06			
55 48	9,997	275.0	−50.6	.79	61	.02			
	11,000	235.8	−59.2		61	.01			
64 04	11,406	221.2	−62.7	.86	61	([1])			Tropopause.
	12,000	201.6	−62.1		60	([1])			
73 37	12,954	173.8	−61.2	−.10	59	([1])			
	13,000	172.4	−61.3		59	([1])			
	14,000	147.4	−63.3		59	([1])			
83 16	14,582	134.4	−64.4	.20	59	([1])			
	15,000	125.9	−65.1		58	([1])			
90 04	15,825	110.1	−66.4	.16	57	([1])			
	16,000	107.5	−66.4		57	([1])			
96 05	16,597	97.5	−66.6	.03	55	([1])			

[1] Less than 0.01 mb.

Launched 1:54 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	127	1,002.2	16.0		82	14.92	s.	2.7	10 St., S.
	500	961.0	15.0		82	13.99			
	1,000	904.0	13.5		82	12.69			
4 40	1,160	885.0	13.0	0.29	82	12.28			
	1,500	851.0	11.4		81	10.92			
10 04	1,910	810.0	9.6	.45	80	9.56			
	2,000	800.0	9.0		80	9.18			
	2,500	753.0	5.6		77	7.00			
	3,000	708.0	2.1		74	5.25			
18 08	3,350	678.0	−.5	.70	71	4.16			
	4,000	623.0	−4.6		61	2.54			
25 32	4,790	564.0	−9.4	.62	50	1.38			
	5,000	549.0	−9.9		50	1.32			
	6,000	482.0	−11.7		50	1.12			
31 50	6,030	480.0	−11.8	.19	50	1.12			
	7,000	423.0	−14.5		39	.68			
37 46	7,280	408.0	−15.1	.26	34	.56			

NASHVILLE, TENN.

Launched 2:06 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	149	1,003.7	13.2		68	10.32	se.	6.7	10 A. Cu., SW.
	500	963.4	11.9						
3 46	964	910.7	10.2	0.37					
	1,000	906.3	10.3						
4 56	1,229	882.1	10.8	−.23					Inversion.
	1,500	853.9	9.8						
7 20	1,815	822.2	8.7	.36					
	2,000	803.2	7.3						
10 44	2,347	770.7	4.6	.77					
	2,500	756.3	4.1						
13 10	2,612	745.9	3.8	.30					
14 14	2,752	733.2	2.9	.64					
	3,000	711.5	2.0						
16 02	3,087	703.5	1.7	.36					
19 18	3,719	650.3	−1.8	.55					
	4,000	627.5	−3.5						
	5,000	553.2	−9.5						
29 06	5,531	515.8	−12.7	.60					
	6,000	485.7	−15.9						
38 42	6,903	430.3	−22.0	.68					
	7,000	425.2	−22.7						
	8,000	369.5	−30.2						
47 14	8,704	335.2	−35.5	.75					
	9,000	321.9	−37.8						
	10,000	279.6	−45.6						
54 18	10,322	264.8	−48.1	.78					
	11,000	239.8	−53.2						
60 19	11,563	219.8	−57.5	.76					

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

ST. LOUIS, MO.

Launched 2 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
m.s.	M.	Mb.	°C.		Pct.	Mb.		M.p.s.	
0 00	170	993.0	12.8		77	11.38	s.	10.7	10 St.Cu., SSW.
	500	957.0	11.2						
	1,000	902.0	8.6						
	1,500	850.0	6.2						
	2,000	799.0	3.5						
9 41	2,310	770.0	1.9	0.51					
	2,500	751.0	3.1						
10 58	2,600	743.0	3.7	−.62					Inversion.
	3,000	708.0	1.4						
	4,000	622.0	−4.5						
20 44	4,490	585.0	−7.2	.58					
	5,000	547.0	−10.9						
	6,000	481.0	−18.4						
30 07	6,020	479.0	−18.6	.75					
	7,000	418.0	−25.0						
38 09	7,640	383.0	−29.1	.65					
	8,000	363.0	−32.4						
	9,000	311.0	−41.3						
45 04	9,100	306.0	−42.2	.90					

Launched 7:50 p.m. Jan. 6, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	170	993.9	11.7		90	12.38	ssw.	9.8	10 St.Cu., SSW.
	500	954.2	9.0		98	11.25			
1 47	609	942.7	8.1	0.82	100	10.80			
	1,000	898.3	5.9		100	9.28			
	1,500	843.8	3.2		100	7.68			
	2,000	794.1	.4		100	6.29			
9 17	2,078	787.2	.0	.55	100	6.11			
10 26	2,230	772.2	−.9	.59	100	5.67			
11 13	2,386	757.2	−1.6	.45	77	4.13			
	2,500	746.0	−.2		77	4.63			
11 43	2,532	743.6	.2	−1.23	77	4.77			Inversion.
	3,000	700.4	−3.4		83	3.83			
15 34	3,397	666.8	−6.5	.77	88	3.12			
	4,000	617.0	−10.7		85	2.09			
20 40	4,557	573.7	−14.5	.69	83	1.45			
	5,000	540.5	−16.9		85	1.19			
	6,000	473.6	−22.5		88	.72			
28 20	6,461	444.9	−25.0	.55	90	.58			
	7,000	413.2	−29.4		89	.36			
35 20	7,822	367.9	−36.2	.82	87	.17			

Launched 2 a.m. Jan. 7,1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	170	997.6	0.0		97	5.93	nnw.	3.6	10 Nb., NNW.
	500	955.9	−6.0						
2 23	626	941.6	−8.3	1.82					Superadiabatic.
3 03	735	928.5	−1.1	−6.61					Inversion.
4 11	893	910.2	−.8	−.19					Inversion.
	1,000	897.0	.7						
5 18	1,137	883.1	2.7	−1.43					Inversion.
	1,500	842.3	.8						
	2,000	790.3	−1.9						
	2,500	743.5	−4.5						
14 53	2,756	720.5	−5.9	.53					
	3,000	698.5	−7.3						
24 14	3,863	624.6	−12.3	.58					
	4,000	613.3	−13.3						
33 27	4,692	560.0	−18.2	.71					
	5,000	537.4	−20.3						
42 50	5,461	504.9	−23.5	.69					
	6,000	468.2	−27.0						
51 59	6,072	464.2	−27.5	.65					
58 46	6,527	435.7	−30.1	.57					

Launched 8:07 a.m. Jan. 7, 1930 (75th mer.)

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	Δt/100 m.	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
0 00	170	1,003.4	−6.1		85	3.12	n.	4.9	10 St. Cu., NNW.
	500	960.0	−13.2						
2 25	740	931.0	−18.2	2.12					Superadiabatic.
	1,000	901.0	−11.9						
4 57	1,210	878.0	−6.3	−2.53					Inversion.
	1,500	842.0	−6.3						
7 14	1,580	836.0	−6.3	.00					Isothermal.
	2,000	792.0	−7.9						
	2,500	741.0	−9.8						
	3,000	695.0	−11.6						
16 48	3,130	683.0	−12.0	.37					
19 47	3,670	635.0	−14.0	.37					
	4,000	609.0	−15.5						
22 19	4,280	587.0	−16.8	.46					
24 24	4,830	545.0	−21.9	.93					
	5,000	534.0	−23.1						
	6,000	464.0	−30.6						
31 28	6,640	423.0	−35.7	.76					
	7,000	402.0	−38.6						
	8,000	346.0	−47.0						
	9,000	298.0	−55.6						
41 04	9,280	285.0	−58.0	.84					

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

ST. LOUIS, MO.—Continued

Launched 8:07 a.m. Jan. 7, 1930 (75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\ m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
	10,000	254.0	−62.4						
	11,000	215.0	−68.5						
50 08	11,810	189.0	−73.3	0.60					Tropopause.
	12,000	182.0	−73.6						
54 17	12,630	164.0	−74.4	.13					
	13,000	154.0	−73.4						
59 11	13,810	134.0	−71.2	−.27					
	14,000	130.0	−71.3						
	15,000	110.0	−71.7						
	16,000	92.0	−72.1						
68 49	16,340	87.0	−72.2	.04					
	17,000	78.0	−72.3						
75 02	17,910	67.0	−72.5	.02					
	18,000	66.0	−72.3						
	19,000	56.0	−70.7						
	20,000	47.0	−69.2						
83 08	20,400	44.0	−68.5	−.16					
	21,000	40.0	−67.4						
	22,000	34.0	−65.6						
88 17	22,750	30.0	−64.2	−.18					

SIOUX CITY, IOWA

Launched 8:03 a.m. Jan. 7, 1930 (75th mer.)

0 00	361	986.8	−20.4		49	0.49	nw.	4.0	1 A. St., SW.
	500	969.0	−22.2		49	.41			
	1,000	904.0	−27.3		50	.25			
2 38	1,070	896.0	−28.2	1.10	50	.23			Superadiabatic.
	1,500	843.0	−16.4		49	.72			
5 25	1,760	815.0	−8.9	−2.80	48	1.38			Inversion.
	2,000	791.0	−9.0		48	1.37			
7 26	2,300	758.0	−9.1	.04	48	1.36			Isothermal.
	2,500	738.0	−10.4		47	1.19			
	3,000	691.0	−13.2		47	.93			
	4,000	604.0	−19.1		47	.54			
16 56	4,600	559.0	−22.5	.58	46	.38			
	5,000	530.0	−25.8		48	.28			
	6,000	461.0	−34.1		51	.13			
26 12	6,160	449.0	−35.9	.86	52	.11			
	7,000	398.0	−41.6		52	.06			
35 48	7,890	348.0	−48.2	.71	52	.02			
	8,000	343.0	−48.8		51	.02			
	9,000	293.0	−55.5		50	.01			
45 38	9,640	266.0	−59.6	.65	49	([1])			Tropopause.
	10,000	252.0	−59.9		50	.01			
47 43	10,360	238.0	−60.2	.08	50	([1])			
	11,000	215.0	−59.4		51	.01			
51 52	11,350	203.0	−58.9	−.13	52	.01			
54 18	11,910	186.0	−54.9	−.71	52	.01			

[1] Less than 0.01 mb.

VICKSBURG, MISS.

(Launched 7:58 a.m., Jan. 7, 1930, 75th mer.)

0 00	92	1,009.0	17.1		86	16.78	se	4.0	10 Nb., SW.
	500	963.8	14.9						
	1,000	906.5	12.1						

TABLE 2.—*Tabulated data of sounding-balloon observations*—Con.

VICKSBURG, MISS.—Continued

(Launched 7:58 a.m., Jan. 7, 1930, 75th mer.)—Continued

Time interval from launching	Altitude, M.S.L.	Pressure	Temperature	$\frac{\Delta t}{100\ m.}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
m. s.	*M.*	*Mb.*	*°C.*		*Pct.*	*Mb.*		*M.p.s.*	
4 31	1,128	892.4	11.4	0.55					
5 17	1,303	874.0	12.0	−.34					Inversion.
	1,500	852.0	10.6						
	2,000	799.9	7.2						
	2,500	751.3	3.8						
	3,000	707.6	.3						
14 58	3,617	657.9	−3.9	.69					
	4,000	625.4	−6.5						
	5,000	550.8	−13.4						
25 00	5,434	520.4	−16.4	.69					
	6,000	483.5	−20.5						
	7,000	421.9	−27.8						
35 02	7,917	371.1	−34.5	.73					
	8,000	367.2	−35.5						
	9,000	317.5	−47.8						
	10,000	273.2	−60.0						
44 35	10,063	270.3	−60.8	1.23					Superadiabatic.
	11,000	233.0	−67.7						
49 00	11,307	221.8	−70.0	.74					Tropopause.
	12,000	198.9	−68.6						
	13,000	169.0	−66.5						
58 41	13,173	164.2	−66.1	−.21					
	14,000	143.7	−66.0						
	15,000	122.6	−65.9						
68 29	15,426	114.8	−65.9	−.01					
	16,000	104.7	−64.8						
78 35	16,759	92.8	−63.3	−.20					
	17,000	89.7	−62.8						
85 35	17,780	78.8	−61.0	−.23					

Launched 2:02 p.m. Jan. 7, 1930 (75th mer.)

0 00	92	1,007.7	20.2		83	19.66	s.	4.5	10 St., S.
	500	960.8	17.7						
	1,000	905.0	14.7						
	1,500	853.7	11.6						
7 26	1,672	836.9	10.6	0.61					
	2,000	804.5	10.4						
10 01	2,149	790.4	10.3	.06					Isothermal.
	2,500	756.5	7.8						
	3,000	712.4	4.3						
20 02	3,699	654.2	−.6	.70					
	4,000	625.9	−2.9						
	5,000	544.8	−10.4						
30 01	5,481	521.2	−14.0	.75					
	6,000	478.5	−17.3						
	7,000	424.4	−23.7						
39 40	7,295	409.5	−25.6	.64					
	8,000	372.5	−31.2						
	9,000	325.0	−39.1						
49 04	9,174	315.0	−40.5	.79					
	10,000	277.7	−48.6						
56 56	10,914	243.1	−57.5	.98					Adiabatic.
	11,000	239.3	−57.8						
60 10	11,540	221.1	−60.0	.40					Tropopause.
	12,000	206.1	−60.5						
	13,000	177.3	−61.4						
	14,000	150.6	−62.4						
75 23	14,089	148.5	−62.5	.10					

SNOW-SURFACE TEMPERATURE

By ROBERT E. HORTON and H. R. LEACH

[Consulting Engineers, Voorheesville, N.Y., Apr. 19, 1934]

(All temperatures in this paper are in Fahrenheit degrees)

On the polar ice shields, on glacier surfaces generally, and above the snow line in mountains, water losses, other than evaporation from snow or ice surfaces, are in general either nil or negligible. Available data on evaporation from snow indicate that it follows the same laws as evaporation from water surfaces if the difference in maximum vapor pressure over ice surfaces is taken into account. The conditions governing evaporation from broad snow surfaces differ from those for water or ground surfaces because the temperature of the latter follows the air temperature closely, with a difference commonly limited to a few degrees and dependent on latitude and elevation. The temperature of a snow or ice surface cannot rise above 32° F. The temperature of the evaporating surface governs the rate of vapor emission. As a result daytime evaporation from snow may be much less than would take place from an unfrozen surface at the same air temperature.

In studying evaporation losses for high latitudes and elevations it becomes important to determine the mean snow surface temperature. There are few data available on this point. Some of those available have been taken by exposing thermometers directly on the snow surface. The cold winter of 1934 at our place, Voorheesville, N.Y., afforded us a favorable opportunity for determining snow-surface temperatures. For this purpose maximum and minimum thermometers were exposed where the snow received full insulation, the entire ther-

mometer being covered with not over one-half inch of snow. Standard Weather Bureau maximum and minimum thermometers were used. It was thought necessary to cover the thermometers to a slight depth because these instruments absorb and radiate heat more readily than the snow surface. In order to compare the results so obtained with those obtained elsewhere from thermometers exposed directly on the snow surface, additional instruments, exposed in the latter manner, were also used. The results of the observations taken with the two sets of instruments are shown on figure 1.

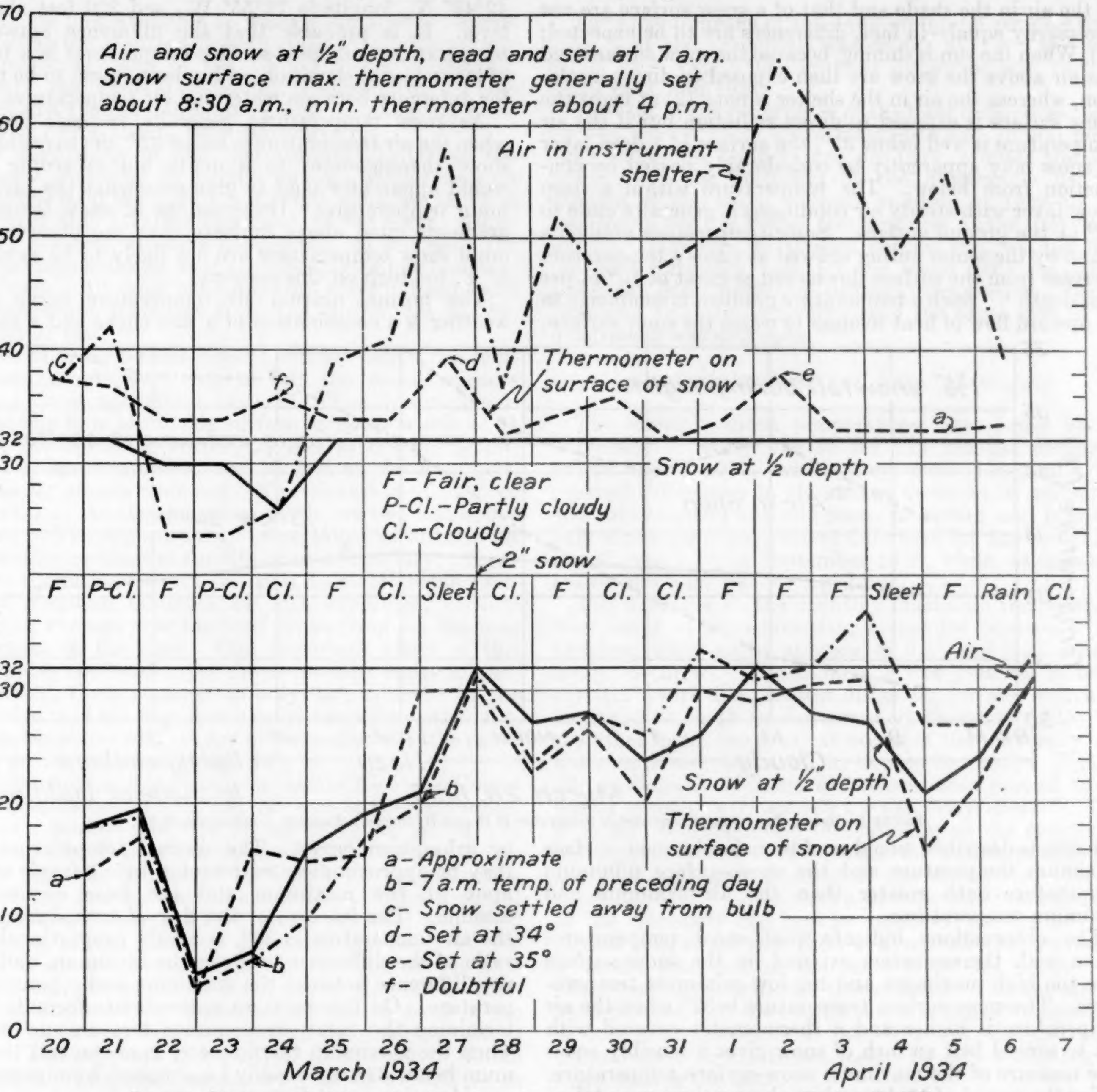

FIGURE 1.—Maximum and minimum air and snow temperatures at Horton Hydrologic Laboratory, Voorheesville, N.Y.

It will be noted that the maximum temperatures shown by the covered thermometer were always precisely 32° when the maximum air temperature, taken in the instrument shelter, was above 32°. The maximum temperatures shown by the thermometer exposed on the snow surface on the same days was always above—sometimes several degrees above—32°. In order to determine which of these series of observations most nearly represents the true surface temperature, additional observations were taken at hourly intervals during one entire day, using a standard Green test thermometer calibrated to ⅒°, readings being taken at hourly intervals. With this extremely sensitive thin-bulb thermometer the snow-surface temperature could be obtained quickly and accurately by laying the thermometer in the surface snow with the bulb barely covered. These observations are shown on figure 2.

At the start, the air in the instrument shelter was 30.5°, rising later above 32°. The air in the open was above 32°. The snow-surface temperature started at 32° and rose to a maximum of 32.7°. The snow was light and newly fallen and about 90 percent of the volume consisted of air. Under these conditions the temperature near the surface of the air-snow mass can apparently rise a fraction of a degree above 32°. As far as the authors are aware this is the first time this phenomenon has been recorded.

Referring to figure 1 it will be noted that the minimum temperatures taken with a thermometer laid on the

snow surface are in general a few degrees below the minimum air temperatures in the instrument shelter. Minimum temperatures taken with a covered thermometer are usually higher but also slightly below the air temperature in the instrument shelter. Data for the whole period December 15, 1933, to April 9, 1934, are not shown on the diagram.

When the air temperature is below 32° the temperature of the air in the shade and that of a snow surface are not necessarily equal—in fact, differences are to be expected: (1) When the sun is shining, because the snow surface and the air above the snow are then exposed to direct insolation, whereas the air in the shelter is not; (2) at night the snow surface is exposed to direct radiation but if the air temperature is well below 32°, the surface of a deep layer of snow may apparently be considerably heated by conduction from below. The temperature within a deep snow layer with steady air conditions is generally close to 32° at the ground surface. Snow-temperature gradients taken by the senior author showed at times a temperature increase from the surface downward as great as 10° F. per foot depth.[1] Such a temperature gradient is conducive to an upward flow of heat tending to warm the snow surface. The effects described would tend to make the snow-surface maximum temperature and the snow-surface minimum temperature both greater than the air-maximum and minimum temperatures.

The observations indicate that snow temperatures taken with thermometers exposed on the snow surface give too high maximum and too low minimum temperatures. The snow-surface temperature is 32° when the air temperature is higher and a thermometer covered with not to exceed half an inch of snow gives a sensibly accurate measure of the maximum snow-surface temperature.

For the period of 15 days when observations were taken both with thermometers on the snow surface and at ½-inch depth, the average minimum temperature at ½-inch depth in snow was 21.4° and the average minimum temperature in the instrument shelter was the same. The average minimum temperature shown by the thermometer exposed on the snow surface for the same days was 20.5° or nearly 1° lower. For the entire period covered by the observations, taking first the maximum temperatures on the 57 days when the air temperature did not exceed 32°, the average maximum air temperature was 18.7° and the average maximum snow temperature ½-inch below surface, 22.1°. For the 109 days of observations when the minimum air temperature did not exceed 32°, its average value was 8.7° and the average minimum temperature of the snow ½-inch below surface on the same days was 13.3°. Taken as a whole, the data indicate that snow surface temperatures when the air temperature is below 32° are, on the average, 3° to 4° higher than the air temperature. The observations were taken at latitude 42°40′ N., longitude 73°55′ W., and 300 feet above sea level. It is probable that the difference between air temperature and snow-surface temperature is a function of latitude and elevation, as has been found to be the case for difference between water and air temperatures.

As snow temperatures generally increase downward when the air temperature is below 32°, the covering of the snow theremometer to a depth not exceeding ½-inch would apparently tend to give somewhat too high minimum temperatures. Observations of snow temperature gradients cited above indicate that the observed minimum snow temperatures are not likely to be as much as ½° F. too high on this account.

The normal diurnal air temperature curve in fair weather is a combination of a sine curve and a radiation or exhaustion curve. The diurnal temperature graph may be approximately represented by a triangle with the apex at the maximum and the base connecting 2 minima. The fraction of the day, if any, during which the air temperature is 32°, is nearly proportional to the ratio of the difference between the maximum and 32° to the difference between the maximum and minmuim temperature. On this basis an approximate formula for determining the mean-snow-surface temperature on days when the maximum thermometer is above and the minimum below 32° can readily be obtained from geometrical considerations, as follows:

$$\theta_s = 32\frac{\theta_g - 32}{\theta_g - \theta_l} + \frac{32 - \theta_l}{\theta_g - \theta_l}\left[\frac{32 + (\theta_l + \Delta)}{2}\right]$$

in which θ_g is the maximum, θ_l the minimum, and θ_s the mean daily snow-surface temperature. Δ is the difference between the air and snow-surface minimum temperatures. From the preceding experiments, allowing for the effect of ½-inch submergence of the thermometer, the value of Δ is apparently $+4°$. For $\theta_g = 44°$ F., $\theta_l = 24°$ F., the mean snow-surface temperature would be 31.2° F., or slightly below freezing, although the mean-air temperature for the day was 34° F. It is hoped that values of Δ at other locations will be obtained and published.

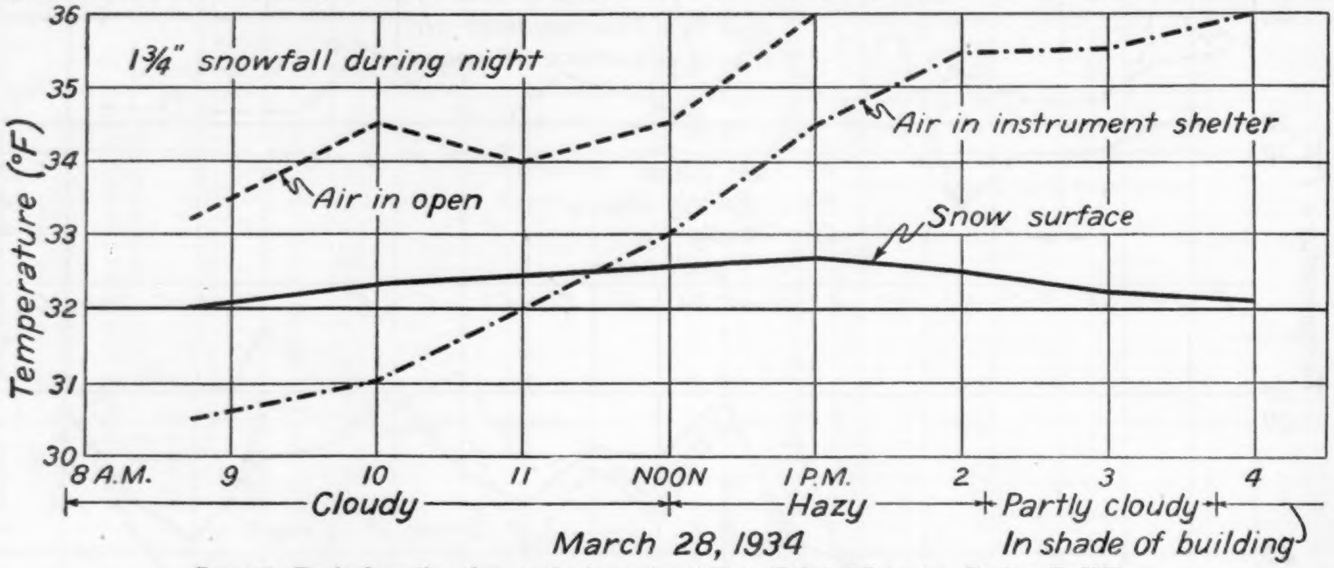

FIGURE 2.—Hourly observations of snow-surface temperature at Horton Hydrologic Laboratory, Voorheesville, N.Y.

[1] Horton, Robert E. The melting of snow; MONTHLY WEATHER REVIEW, December 1915, v. 43, pp. 599–606.

TEMPERATURE RELATIONS BETWEEN THE TWO CHICAGO, ILL., WEATHER BUREAU STATIONS: CAMPUS OF THE UNIVERSITY OF CHICAGO AND THE ROOF OF THE UNITED STATES COURTHOUSE

By C. A. DONNEL

[Weather Bureau office, Chicago, Ill., April 1934]

(NOTE: All temperatures are in Fahrenheit degrees)

There are now available 16 years' synchronous records obtained at the Weather Bureau stations: (1) University of Chicago; (2) roof of the United States courthouse (formerly the Federal building), Chicago, Ill. These stations are about 7 miles apart, and distant from Lake Michigan 1 mile and 7/10 mile, respectively.

The dimensions of the thermometer shelter at the university are 36 by 38 by 50½ inches. Its location on the campus is on the quadrangle about which are grouped Rosenwald Hall (Walker Museum), to the north; a long building housing women's dormitories, to the east; the social sciences building, to the south; and the law building, to the west. All these buildings are 71 feet in height and their respective distances from the shelter are 92, 83, 171, and 91 feet.

Three of these buildings were erected before the temperature records were begun, but the social sciences building dates only from 1929–30. The quadrangle is open to the flow of outside surface air for a width of 61 feet at the northeast corner, 23 feet at the northwest, 19 feet at the southwest, and 23 feet at the southeast. The shelter stands over sod. The elevation of its floor is 6 feet, and the thermometers inside are two feet above the floor. The exposure may be regarded as suitable for representing residential conditions in a large city. However, it should be pointed out that Lake Michigan exercises a profound influence at both exposures, because during an average year the wind blows from off the lake 42 percent of the time. One important effect of this lake wind is the lowering of the mean daily range in temperature at these stations to only 15°, whereas in the western part of the city, 8 or 9 miles away from the lake, the range is about 20°. A few miles farther west the range is still greater, approximating 22°.

The dimensions of the thermometer shelter at the United States courthouse, which, like the one at the university, also has a peaked roof, are 39 by 42 by 54 inches. It stands on the slate-in-cement roof of the 8-story north wing of the courthouse, and its floor is 10 feet above the roof, or 139 feet above the street level. The dome of the courthouse rises 168 feet above this roof and is 42 feet south of the shelter. Fourteen feet west of the shelter is a north-south skylight, the ridge of which is 9 feet, and the eaves 3 feet, above the roof. High buildings surround the shelter and, with the dome of the United States courthouse, keep it in the shade at various times. The exposure is typical of those used to obtain atmospheric temperatures on the roof of a building in the heart of the business district of a large city.

For the entire 16 years of comparative records the annual mean temperature at the university averages exactly 1° lower than the United States courthouse mean. In each the means were lowest at the university. The greatest difference was 1.3°, in 1919 and 1920, and the least, 0.7° in both 1932 and 1933.

The annual means of the daily maximum temperatures averaged 0.5° lower at the university than at the courthouse. The greatest difference was 0.9°, in 1925, and the least, 0.2°, both in 1922 and 1933.

65288—34——3

The annual means of the daily minimum temperatures show that the university was colder by 1.6°, and also colder each year. The greatest difference was 1.2°, in 1926, 1932, and 1933.

The fact of the occurrence of the least differences, both for the annual mean daily maximum and annual mean daily minimum temperatures in 1933, arouses the suspicion that the enclosing of the quadrangle by the erection of the social sciences building in 1929–30 has resulted in slightly higher temperatures at the university station. However, as already pointed out, we find that the least difference both for the mean daily maximum and mean daily minimum temperatures occurred also in 1922 and 1926, respectively, when the south side of the quadrangle was still open.

CONSIDERATION OF THE DATA BY MONTHS

The monthly mean temperatures were lower at the university in every one of the 192 months of record except April 1927, when they were identical. The greatest differences in the means occurred in midwinter and midsummer, and the least, in spring and late fall. July shows that the greatest difference for any individual month was 2.1°, in September 1928, while, as indicated above, the least was for April 1927, 0.0°.

The averages of the monthly maximum temperatures were lower at the university, except for September and October, when slight excesses of 0.3° and 0.1°, respectively, occurred. The difference was greatest in January, 1.2°, with the greatest difference for any individual month, 2.0°, both in January and February 1925. On the other hand, the greatest excess of the university over the courthouse was 1.1°, in September 1922. Perhaps the comparatively large differences that prevail in the winter months were caused by the "city effect." That is to say, the maximum thermometer at the courthouse was more affected by heat from the buildings than was the maximum thermometer at the university. On the other hand, the excess shown in September and October at the university can best be explained by the fact that at that time of the year there is a reduced wind movement from the lake and at the same time not much "city effect" on the courthouse thermometer. As has already been pointed out, the courthouse maximum thermometer is somewhat nearer the lake than is the university thermometer and is thus affected by lake winds slightly more than is the latter.

For all 12 months the mean minimum temperatures averaged lowest at the university. The differences were greatest in July, August, and September, 2.2°, 2.5°, and 2.4°, respectively, while they were least in late winter and early spring, 0.9°, for February, March, and April each. Doubtless the larger differences in late summer and early fall are due in part to the occurrence of good radiation conditions at that time and in part to the fact that the nighttime winds off the lake at that season are comparatively warm. The greatest difference in the means for any month was 4.0°, in September 1928, while

the least difference was 0.0°, both in February and April 1932.

The annual mean temperatures at the two locations appear to be slightly less divergent in recent years than in the years at the beginning of the records. For the first 4 years the average difference was 1.2°, whereas for the last 4 years it was 0.8°. That this change has been brought about almost wholly by more nearly equal minimum temperatures is revealed by the fact that the average annual mean daily maximum temperatures for the first 4 years of record were 0.5° lower at the university, and for the last 4 years 0.4° lower, whereas the mean daily minimum temperatures were 1.8° lower at the university for the first 4 years, but only 1.3° lower for the last 4. Whether this discrepancy of 0.5° is due to the use of different minimum thermometers having unlike corrections that were not applied, to the erection of the social sciences building, or to something else, is uncertain. Possibly the differences are of a wholly natural character.

Finally, the most interesting result in this comparison is the fact that these two stations, only 7 miles apart and with about the same influence exercised on each by a large body of water, show divergences in the differences between their monthly mean temperatures of 1° or more in 9 of the 12 months. This divergence is greatest, 2°, in September. Even the annual mean temperature itself shows a divergence of 0.6°. And, of course, even larger divergences appear both for the monthly mean daily maximum and mean daily minimum temperatures, ranging for the mean maximum temperatures from 1° in December to 1.8° in February, and for the mean minimum temperatures from 1.3° in June to 3.1° in September. These facts show what uncertainty may exist when interpolating for missing records. If these comparatively large divergences exist for stations as close together as 7 miles it is reasonable to assume that as large or even larger divergences exist for stations farther apart, as, for example, in the case of two cooperative stations 25 or 30 miles apart.

METEOROLOGICAL CONDITIONS AND WHEAT YIELDS IN FORD COUNTY, KANS.

By CLARENCE E. KOEPPE

[Southwest Missouri State Teachers College, Springfield, Mo., Apr. 24, 1934]

There have been numerous studies made of the relation of weather conditions to crop yields—many quantitative but most of them only qualitative. Several quantitative studies of *wheat* yields and weather conditions have been made during the past 20 years, notably by J. W. Smith, particularly in Ohio, and by Hessling in the Argentine. There is, however, marked disagreement in almost all of the studies, which have been made, due probably to at least two causes: (1) The difference in geographic location and consequently in physical conditions. For example, rainfall seems to be less critical in Ohio than in Kansas, because in Kanass available moisture frequently is insufficient, while in Ohio wheat rarely suffers from lack of moisture; (2) the interrelations of the meteorological elements are so complex that it is difficult to establish whether, for example, a poor yield of wheat is due to too little rain in September, too high temperatures in October, lack of snowfall in January, too much rain in April, too strong winds in May, or whatnot else. There are discussed here only a few of the more apparent, though perhaps less real, relationships between yields of wheat and the elements of temperature (including maximum and minimum), rainfall, snowfall, rainy days, and wind velocities. No account has been taken of frost, hail, ice storms, sunshine, and cloudiness; and only slight consideration has been given to frequencies and sequences of weather elements.

The original plan was to select long-period data for at least three counties in Kansas, and to calculate partial and multiple correlations. Obviously the task was too great. Hence, and unfortunately so, this paper deals only with a 10-year period, 1921–30, for yields of wheat in Ford County, Kans., and with the meteorological data for the corresponding 10-year period at the county seat, Dodge City, which are assumed to be representative of those of the area in question. The meteorological year was taken from August 1 to July 31, rather arbitrarily to be sure, yet not entirely without justification since some wheat is harvested in July. Probably rainfall in July, however, has as much to do with the wheat crop the following year as it does with that of the same year.

The methods employed in arriving at the conclusions which follow were the usual ones, viz, the plotting of the data to note any marked correlations and in order to determine whether the relationship between the wheat yields and each of the several weather elements was linear or otherwise; the calculation of mainly simple correlation coefficients, with some partial and multiple correlations; the calculation of the probable error; and so on. In some instances there was very definite linear relationship; in others the points were so scattered that even a parabola failed to fit them. The attempt here, however, is not to discuss methods of correlation, but merely to point out a few of the more significant and striking relationships which seem to exist between the meteorological conditions by months and the wheat yields the following season.

There is a general impression that rainfall is the most critical factor in the production of winter wheat in central and western Kansas. Results of this study failed to show any such outstanding connections. Probably the most significant relationship was the fact that fairly moist Augusts, Septembers, Octobers, Januarys, and Februarys, and distinctly dry Aprils were followed by good yields of wheat the following Junes or Julys. The exceptionally low yields of 1925 and 1927 were preceded by April rainfall above normal, while the exceptionally high yields of 1926 and 1928 were preceded by April rainfall below normal. The low yield of 1923, which was 6 bushels to the acre when only one-fourth of the normal acreage was harvested, was preceded by a dry April, but by a May in which the rainfall was three times the normal amount. Comparison of wheat yields with the longest rainless intervals in the March-to-May period gave a negative correlation of 0.32, which figure has little if any significance. There was even less correlation when the period was extended from February to June, inclusive. A large number of rainy days in August and October seemed to be favorable for large yields the following year.

The total yearly snowfall showed a correlation of +0.50. April snowfall showed a relatively high correlation of +0.71, although this high figure may be due to too scattered data, many Aprils having no snow; that is, the yields of wheat may have been large in spite of April snowfall rather than because of it. Snow in February seemed to be desirable, more so than in March; but snowfall in November and December correlated negatively,

although the coefficients -0.15 and -0.24 were too small to be considered as significant.

The most striking point in connection with *temperature* was the fact that both maximum and minimum temperatures from November to March, inclusive, had practically no influence on wheat yields the following season. But temperatures below normal in both October and April were followed by large yields the following summer. The remakably high yield of 1926, which was 21 bushels to the acre, followed an October in which 24 days had both maxima and minima below their normals for the month. On the other hand, a correspondingly high yield in 1928 followed an October which experienced maximum temperatures slightly above normal, although the minima were practically normal. Minimum temperatures below normal in June seemed to favor higher yields, the correlation being -0.60. Correlation of the number of days in a month in which temperatures were above or below certain temperatures which seemed to be critical, revealed practically no relationship except in October, April, and possibly November. Large yields seemed to be favored by a large number of frost days in both October and April; but temperatures below 20° in November seemed to be slightly unfavorable. An interesting point was the fact that the correlation between wheat yields and the number of 0° days in January was exactly zero. The only other relationship revealed was the fact that temperatures in excess of 85° in May were slightly unfavorable, the correlation being -0.35.

Thornthwaite's formula,[1] $\frac{P}{E}=11.5\left[\frac{P}{T-10}\right]\frac{10}{9}$, in which $\frac{P}{E}$ is the precipitation-evaporation ratio, P the precipitation in inches, and T the temperature in degrees Fahrenheit, was used to compute ratios for each month for the entire period, and these ratios were correlated with wheat yields. This was done in order to show the relation between wheat yields and two variables, temperature and precipitation. The results revealed nothing more than did either temperature or pecipitation alone. That is, high precipitation-evaporation ratios in April were followed by low wheat yields, and this was also true to a slight degree for August and December; while large precipitation-evaporation ratios in September favored high wheat yields the next summer.

The most conclusive of all correlations were those with wind velocities. The only significantly positive correlation was in December with a coefficient of 0.44, indicating the desirability of strong winds in that month. This seems absurd, and doubtless the yields of wheat in summer are good in spite of high winds in December. Wind velocities in October, February, April, and July revealed nothing worth considering. But strong winds in September and March clearly affected wheat yields, the correlations being -0.77 and -0.74, respectively. This was only slightly less true in May and June. Strong winds in November and January also seemed to indicate an adverse effect on wheat.

The general conclusion is that a cool October with rather dry air, but frequent small showers, and a cool April with a small amount of precipitation, few rainy days, but relatively moist air and not too much wind in early fall, late winter and spring, are favorable conditions for good yields of wheat the following season.

[1] C. W. Thornthwaite: The Climates of North America According to a New Classification. *Geographical Review*, vol. 21, 1931, p. 639.

CENTRAL OFFICE OF UNITED STATES WEATHER BUREAU STRUCK BY LIGHTNING

By ALBERT K. SHOWALTER

[Weather Bureau, Washington, April 1934]

At about 3:50 p.m., April 24, 1934, I was using the extreme northwest corner of the main building of the Weather Bureau, Washington, D.C., as a sighting point, from a west window of the annex, to check the movements of the clouds in a vigorous thunderstorm that was approaching from the west-northwest. While looking at this corner it suddenly became a terminus for a lightning discharge which occurred between the building and a northwest cloud. The discharge had the appearance of an ordinary streak of lightning which flashes from clouds to earth. However, at the same instant there appeared adjacent to the corner struck an exceptionally brilliant blaze of reddish light, which was somewhat round but not a perfect sphere, and pieces of brick and stone were thrown in all directions, except upward.

The thunder was not very loud. I had been quite close to lightning strokes before and each time I heard a deafening crash which left a ringing sensation in my ears for some minutes afterward. On this occasion however, I heard only a small crack at almost the instant of the flash.

I have discussed this lightning flash with several other persons who were in the room with me, or in adjoining rooms at the time of its occurrence. Their impressions were in general in harmony with my own. Mr. J. H. Gallenne observed the streak of lightning in the northwest but did not see it strike. Mrs. I. J. Brinks saw the flare adjacent to the corner struck and said it had a very reddish tint and although it was somewhat round it did not have the exact appearance of a ball. Mrs. R. R. Kass saw it also and said that to her it seemed to be a distinct ball.

NOTE.—No one was hurt and the material damage was inconsequential.—EDITOR.

THE "SINKING" OF LAKE AND RIVER ICE

By W. J. HUMPHREYS

In the spring, as Tennyson puts it, some of us are prone to obsessions. One of these obsessions is that of the boatman, fisherman, and lots of others, who swear that at this season surface ice becomes rotten, or honeycombed, and sinks. They know it sinks because in the evening the lake, for instance, may be covered with a sheet of old ice from end to end and shore to shore, and by the next morning no trace of the ice left, save little patches here and there along the water's edge. "Of course it sank", they say, "how else could it have disappeared so rapidly?" And river men tell us not to worry about the ice coming downstream from a broken jam above, for before getting very far it will go to the bottom like a rock. Evidently it can be sunk, and sometimes is, just

as a boat may be, by overloading with a substance denser than water, such as sand, gravel, or mud, but as this requires 1 pound of sand, for example, to every 7 pounds of ice, a proportion hundreds of times greater than that of the suspended matter to the water in even a muddy river, it is obvious that such sinking cannot occur on lakes, except rarely at the mouths of flooded streams, nor at all commonly anywhere else.

This sinking by overloading every one admits. The argument, and need for explanation, comes when it is insisted that honeycombed ice, wherever it may be, sinks like water-logged wood, and perhaps for the same reason.

This is too much for the physicist to take "lying down", for he refuses to believe that anything 10 percent lighter than water, as ice is, actually does or can sink in that water, whatever it may seem to do in the eyes of no matter how many witnesses. However, the ice does disappear. If it doesn't sink it must melt, but then how can it all melt in a few hours in the same water in which it had remained for weeks without melting?

To simplify the problem consider the behaviour of ice on a lake of moderate size in a region where the water remains frozen over through the winter. The matters of importance are:

1. When winter approaches the surface water cools, becomes denser and sinks until from bottom to top the water has the temperature appropriate to its maximum density, that is, 39° F., very nearly.

2. As the surface water is further cooled it becomes lighter and remains at the top where, presently, it freezes to ice, and in so doing expands by about one-tenth its original volume, and thus becomes approximately 10 percent lighter in the solid form than it was while in the liquid state. Hence it floats.

3. In the process of freezing the dissolved substances in the water (in lake and stream water there always are such substances) are at first expelled by the forming ice and later entrapped, in part, in the water between the crystal faces or in crevices of whatever kind.

4. With a little further cooling this interfacial and cavity concentrate, which always has a more or less lower freezing point than pure water, also is frozen and the sheet of ice thus rendered continuous and solid throughout, save for such air bubbles as may be present.

5. Under the influence of moderating weather and increasing sunshine as the spring days lengthen, the ice slowly warms up until its least pure portions, that is, those in the crystal cavities and over the crystal faces, melt—melt at a small fraction of a degree, often as little as one-thousandth of a degree, perhaps, below the freezing point of the purer ice. When this happens the bricks (crystals) still are solid, but the mortar that bound them together is fluid, and the whole structure weak. The ice has become rotten, as generally expressed, and soon more or less cracked, honeycombed, and water-logged. This last condition is partly, at least, caused by top-surface melting, and rain, perhaps.

6. Even yet there has been very little melting at the undersurface of the ice because there the water, being in contact with ice, is at the freezing (or melting) temperature 32° F. And because, owing to protection from winds by the sheet of ice, there is no wave action to bring up the denser, *warmer* water from below.

7. Comes a storm. The weak ice starts to break and soon is extensively broken. Then the churning action of the waves brings up an abundance of water of several degrees higher temperature than the melting point, and in the course of a few hours, or a day, at most, much of the ice, if not all of it, has melted away—gone so rapidly as to force the belief on most of us that it just must have sunk.

And this is how the ice sinks, "sinks" by melting quickly, on lake and on river, and the only possible way reasonably clean ice can sink. In short, while ice can be sunk by an overload of sand, or other dense material, all moderately clean ice, such as that on lakes, that has "sunk" hasn't sunk at all; it has just melted in a hurry. Even anchor ice didn't sink—it formed in place.

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RECENT ADDITIONS

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING APRIL 1934

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged below normal for April at all three Weather Bureau stations. The Lincoln values are in general well below the average for the month owing to the beginning of dust-laden skies which persisted from the 9th through the end of the month. Values of 0.24 gram calorie, as were recorded on the 9th are unusually low and seldom observed except when definite water-vapor clouds are present.

Table 3 shows an excess in the total solar and sky radiation received on a horizontal surface at all stations except Washington, Pittsburgh, and Fairbanks.

Turbidity measurements were obtained on 8 days at Washington and show the usual average variation throughout the month except on the 24th, when the sky was so laden with dust that accurate determinations of the depletion due to dry dust were impossible.

Polarization measurements obtained at Washington on 9 days give a mean of 57 percent with a maximum of 62 percent on the 28th. At Madison measurements on 6 days give a mean of 56 percent with a maximum of 64 percent on the 12th. All the above values are below the April normals.

TABLE 1.—*Solar radiation intensities during April 1934*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D.C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					Air mass P.M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Apr. 2	7.57					1.42					6.50
Apr. 10	7.29			0.64	0.85	1.22					7.06
Apr. 12	3.81				1.10	1.30					8.81
Apr. 18	7.04	0.58	0.70		1.00	1.22					6.27
Apr. 21	3.15			.93	1.12	1.42					2.87
Apr. 24	8.48			.47	.66						10.21
Apr. 25	2.74			.96	1.21						3.00
Apr. 26	4.17	.54	.78	.90	1.06						3.81
Apr. 28	2.06	.80	.89	1.02	1.25	1.34					2.36
Means		.64	.79	.82	1.03	1.32					
Departures		−.06	+.01	−.07	−.04	−.04					

Madison, Wis.

Date	8 a.m. e	A.M. 5.0	A.M. 4.0	A.M. 3.0	A.M. 2.0	[1] 1.0	P.M. 2.0	P.M. 3.0	P.M. 4.0	P.M. 5.0	Noon e
Apr. 7	4.37		0.88	1.01	1.19						5.16
Apr. 9	5.36		.76	.87	1.09	1.42					7.87
Apr. 12	1.78			1.19	1.25	1.61					1.88
Apr. 14	4.17					1.58					3.63
Apr. 16	3.15				.82	1.48					3.15
Apr. 18	5.36				1.02						5.56
Apr. 19	3.99			.52							3.30
Apr. 21	3.15			1.12	1.29						2.16
Apr. 25	2.62		.98	1.12	1.30	1.54	1.19				1.96
Apr. 26	4.37				.66	1.49	1.21				2.87
Apr. 27	4.37					1.52	1.37				2.06
Apr. 28	2.36		.55	.73	.93	1.35					3.00
Means			.79	.94	1.06	1.50	1.26				
Departures			−.12	−.08	−.13	+.06	+.06				

Lincoln, Nebr.

Date	8 a.m. e	A.M. 5.0	A.M. 4.0	A.M. 3.0	A.M. 2.0	[1] 1.0	P.M. 2.0	P.M. 3.0	P.M. 4.0	P.M. 5.0	Noon e
Apr. 6	6.02							1.01	0.88	0.79	6.02
Apr. 7	5.16		0.85	1.00	1.20	1.41					4.95
Apr. 9	7.87	0.74	.85	1.02	1.15	1.41	0.85				6.76
Apr. 12	3.63	.99	1.10	1.22	1.33	1.44	.98	.65	.37	.24	2.26
Apr. 13	2.87	.97	1.07	1.20	1.37	1.57	1.29	1.10	.96	.84	2.36
Apr. 14	3.15			.70	1.03						3.30
Apr. 16	3.30			.68	1.04	1.41	1.12	.84	.65	.50	3.15

TABLE 1.—*Solar radiation intensities during April 1934*—Contd

Lincoln, Nebr.—Continued

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					Air mass P.M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Apr. 17	4.95						0.98	0.76	0.56	0.43	6.27
Apr. 18	7.87	0.58	0.69	0.88	01.06	01.43					7.87
Apr. 19	2.62		.38	.47							2.87
Apr. 20	2.62	.28	.39	.58	.98	1.44	.80	.62	.51	.43	2.26
Apr. 21	1.96		.47	.66	1.04						2.74
Apr. 24	3.00	.32	.44	.67	.94	1.37	1.15	.97	.80	.69	2.74
Apr. 27	2.62		.53	.66	.92	1.34	1.03	.75	.57	.46	3.00
Apr. 28	2.87		.69	.85	1.07	1.43					3.81
Means		.65	.68	.81	1.09	1.42	1.02	.84	.60	.55	
Departures		−.06	−.13	−.15	−.09	−.02	−.14	−.12	−.16	−.14	

Blue Hill, Mass.

Date	8 a.m. e	A.M. 5.0	A.M. 4.0	A.M. 3.0	A.M. 2.0	[1] 1.0	P.M. 2.0	P.M. 3.0	P.M. 4.0	P.M. 5.0	Noon e
Apr. 2	5.8						1.13	0.69			7.3
Apr. 3	4.8				1.13	1.32	.95	.80			4.4
Apr. 5	1.9				1.14	1.34	1.18	1.14	0.89		2.5
Apr. 8	3.7				1.25	1.53	1.26	1.05	.89		2.5
Apr. 9	5.2				1.15	1.25					4.2
Apr. 10	4.8				1.15	1.40	1.14	.93	.84		5.2
Apr. 11	3.9				1.23	1.44					5.6
Apr. 13	4.2				1.07	1.31					2.8
Apr. 15	5.0				1.02	1.25					5.0
Apr. 16	5.8				.95	1.50					7.6
Apr. 17	8.2					1.45	.98				4.0
Apr. 18	5.4				1.06	1.23					2.9
Apr. 19	7.3				.78	1.38					4.6
Apr. 21	4.6				.98	1.41					4.2
Apr. 22	5.2					1.12	.80				6.2
Apr. 24	9.8					1.30	.70				8.8
Apr. 25	4.4				.99	1.45					3.1
Apr. 26	3.1				1.27	1.50	1.25				2.0
Apr. 28	3.1				1.26	1.45					1.6
Apr. 29	2.4				1.21	1.47	1.00	.86			2.3
Apr. 30	2.7				.90	1.19					4.2
Means					1.09	1.36	1.03	.91	.87		

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Mount Washington
	Gram calories per square centimeter														
1934	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Apr. 2	391	305	370	303	314	619	330	318	533	554	486	360	566	426	479
Apr. 9	321	377	480	300	403	640	267	324	541	385	482	280	423	445	488
Apr. 16	373	416	576	368	386	645	263	372	578	369	474	430	521	430	463
Apr. 23	480	526	598	449	509	692	403	330	522	627	463	438	618	538	374
	Departures from weekly normals														
Apr. 2	+4	−66	−53	+3	−19	+89	+43	−15	+111	+131	+14	+14			
Apr. 9	−79	−27	+47	−41	+65	+66	−53	−58	+85	−50	+14	+32			
Apr. 16	−48	+18	+142	+44	+32	+67	−81	−8	+112	−53	±0	+63			
Apr. 23	+40	+84	+139	+102	+118	+73	+40	−34	+40	+175	−15	+72			
	Accumulated departures on Apr. 29														
	−2,037	+840	+1,694	+3,115	+4,081	+2,534	−2,163	−1,085	+3,213	+3,640	+2,310	+4,298			

TABLE 3.—*Total, I_m and screened, I_y, I_r, solar radiation intensity measurements, obtained during April 1934, and determinations of the atmospherec turbidity factor, β, and water-vapor content, w= depth in centimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D.C.

Date and hour angle	Solar altitude	Air-mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w-s}}{1.94}$	$\frac{I_{w-s}-I_m}{1.94}$	W
									Percentage of solar constant		
Apr. 2	° ′	m	gr. cal.	gr. cal.	gr. cal.						cm
2:14 a.	40 11	1.55	0.974	0.723	0.585	0.169	0.162	0.166	60.5	10.3	1.1
2:36 a.	41 00	1.52	.994	.728	.589	.160	.157	.158	62.1	10.9	1.3
0:44 a.	54 31	1.23	1.194	.870	.699	.147	.117	.132	71.0	9.4	.9
0:40 a.	54 46	1.22	1.180	.872	.701	.159	.120	.140	69.3	8.4	.5
Apr. 10											
5:00 a.	16 36	3.47	.582	.466	.383	.136	.123	.130	44.9	14.9	3.1
4:55 a.	17 34	3.28	.607	.474	.389	.131	.145	.138	45.5	13.9	2.2
4:51 a.	18 20	3.16	.601	.496	.405	.162	.142	.152	43.5	12.6	1.6
4:44 a.	19 43	2.95	.638	.506	.418	.153	.141	.147	46.7	13.9	2.5
4:38 a.	20 50	2.80	.650	.522	.436	.175	.154	.164	45.0	11.5	1.1
4:34 a.	21 36	2.70	.661	.538	.443	.185	.184	.184	43.2	9.1	.4
4:09 a.	26 26	2.25	.812	.592	.495	.136	.175	.156	52.2	10.5	.8
4:04 a.	27 23	2.17	.822	.606	.506	.145	.175	.159	52.8	10.4	.8
4:00 a.	28 07	2.12	.827	.612	.510	.150	.177	.164	53.0	10.4	.9
3:36 a.	32 38	1.86	.858	.640	.528	.170	.180	.175	56.4	12.0	1.8
3:29 a.	33 55	1.79	.856	.646	.530	.182	.182	.182	56.5	12.2	1.8
3:25 a.	34 39	1.76	.855	.656	.530	.189	.159	.174	56.4	12.2	1.9
3:21 a.	35 23	1.73	.859	.660	.532	.194	.156	.175	56.7	12.2	2.0
1:52 a.	50 05	1.30	1.089	.754	.616	.147	.195	.171	64.2	8.0	.5
1:48 a.	50 30	1.29	1.096	.757	.619	.144	.198	.171	64.4	7.9	.4
0:32 a.	58 09	1.18	1.102	.771	.632	.188	.210	.199	63.1	6.3	.3
0:28 a.	58 20	1.18	1.097	.772	.634	.172	.216	.194	64.0	7.4	.4
Apr. 12											
3:28 a.	34 38	1.26	1.156	.919	.743	.141	.068	.104	65.1	5.0	.2
3:24 a.	35 22	1.73	1.156	.921	.745	.148	.068	.108	64.9	4.8	.2
Apr. 18											
5:18 a.	14 52	3.85	.710	.569	.458	.085	.069	.077	52.4	15.6	3.5
5:12 a.	16 02	3.59	.751	.580	.463	.070	.072	.071	56.3	14.3	3.2
2:23 a.	47 33	1.35	1.139	.828	.634	.104	.050	.077	75.7	15.4	4.8
2:17 a.	48 30	1.33	1.137	.831	.642	.112	.060	.086	74.0	14.8	4.2
Apr. 21											
4:58 a.	19 22	2.99	.933	.748	.609	.090	.064	.077	58.8	10.3	.7
4:52 a.	20 23	2.85	.964	.751	.513	.082	.070	.076	59.8	9.7	.5
4:30 a.	24 45	2.37	1.025	.821	.659	.100	.060	.080	59.0	5.7	.2
3:25 a.	37 12	1.65	1.230	.922	.760	.108	.090	.099	69.2	5.2	.2
3:20 a.	38 09	1.62	1.247	.930	.767	.112	.090	.101	68.8	4.0	.1
Apr. 24											
5:00 a.	19 37	2.96	.487	.348	.286	.148	.192	.170	43.3	17.7	>5.0
4:52 a.	21 10	2.75	.510	.356	.288	.145	.192	.168	44.5	18.0	>5.0
4:00 a.	31 14	1.93	.674	.469	.375	.160	.220	.190	52.0	17.0	>5.0
3:56 a.	32 00	1.88	.669	.473	.376	.170	.225	.198	51.3	16.7	>5.0
1:48 a.	54 34	1.23	.801	.560	.434	.220	.230	.225	60.0	18.7	>5.0
1:44 a.	55 09	1.22	.808	.563	.435	.220	.230	.225	60.0	18.0	>5.0
0:50 a.	61 38	1.14	.832	.578	.457	.230	.250	.240	57.0	14.2	>5.0
0:46 a.	61 59	1.14	.832	.581	.465	.240	.260	.250	57.0	14.2	>5.0
Apr. 25											
5:06 a.	17 52	3.24	.856	.708	.578	.105	.067	.086	55.1	10.6	.6
5:00 a.	19 02	3.06	.888	.711	.581	.094	.068	.081	57.6	11.1	.7
4:52 a.	20 35	2.83	1.005	.773	.636	.075	.069	.072	62.0	9.7	.5
4:48 a.	21 22	2.73	1.036	.786	.646	.070	.070	.070	63.0	9.1	.4
4:24 a.	26 48	2.21	1.162	.878	.720	.076	.068	.072	67.4	7.0	.3
3:12 a.	40 31	1.54	1.231	.954	.754	.088	.060	.074	74.4	10.4	1.0
Apr. 26											
5:28 a.	14 34	4.00	.776	.609	.521	.086	.092	.089	48.5	8.1	.3
5:24 a.	15 21	3.78	.786	.524	.524	.089	.101	.095	49.3	8.3	.3
5:09 a.	18 04	3.19	.876	.679	.568	.094	.104	.099	52.7	6.4	.2
5:04 a.	19 13	3.02	.872	.682	.571	.098	.094	.096	54.2	9.0	.4
4:55 a.	20 06	2.82	.914	.723	.591	.098	.072	.085	58.8	11.2	1.0
4:49 a.	22 10	2.63	.952	.726	.603	.094	.094	.094	58.6	9.1	.4
4:44 a.	23 00	2.55	.956	.730	.606	.098	.102	.100	58.2	8.4	.4
4:25 a.	26 48	2.21	1.018	.788	.647	.118	.086	.097	62.5	10.3	.6
4:20 a.	27 46	2.15	1.045	.791	.650	.104	.090	.097	63.0	9.1	.5

Atmospheric conditions during solar radiation measurements.

Apr. 2. Temp. 12°–15 C., wind, N–12; vis. 20. St. Cu. early; obs. stopped by Fr. Cu. and Cu.

Apr. 10. Temp. 11°–18° C., wind, SE–15; vis. 20. Cu. from noon on.

Apr. 12. Temp. 9°–10° C., wind, NW–18; vis. 30. A. St. at 10 a.m.

Apr. 18. Temp. 9° 17° C., wind, E–12; vis. 20., Cirri. 11; a.m.

Apr. 21. Temp. 8°–10° C., wind., NW–13; vis. 30 Cirri. noon.

Apr. 24. Temp. 18°–25° C., wind, W–20; vis. 20, Fr. Cu. at noon.

Apr. 25. Temp. 7°–9° C., wind, NW–12; vis. 20., Fr. Cu. at noon.

Apr. 26. Temp. 7°–11° C., wind, NW–14; vis. 20, Fr. Cu. 9 a.m.

TABLE 3.—*Total, I_m and screened, I_y, I_r, solar radiation intensity measurements, obtained during April 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w= depth in centimeters, if precipitated*—Continued

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air-mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	I_{w-s}	$I_{w-s}-I_m$[1]	W
									Percentage solar constant		
Apr. 2	° ′	m	Gr. cal.	Gr. cal.	Gr. cal.						mm
2:57 p.	35 51	1.71	1.083	0.794	0.636	0.112	0.101	0.106	67.6	11.8	17.0
Apr. 3											
1:22 a.	48 47	1.32	1.239	.868	.711	.125	.149	.137	68.9	5.0	1.8
0:33 a.	52 18	1.26	1.299	.932	.744	.091	.077	.084	76.4	9.4	9.0
2:42 p.	38 29	1.60	1.125	.803	.633	.091	.081	.086	72.6	14.6	48.0
Apr. 5											
2:41 a.	39 14	1.58	1.301	.925	.737	.060	.054	.057	76.8	9.7	8.0
1:02 a.	51 36	1.28	1.348	.931	.746	.066	.074	.070	78.0	8.5	5.5
0:52 p.	52 00	1.27	1.357	.948	.757	.069	.075	.072	78.0	8.0	4.5
3:15 p.	33 31	1.81	1.225	.886	.711	.068	.064	.066	73.0	9.8	7.9
Apr. 8											
2:12 a.	44 15	1.43	1.371	.963	.756	.044	.028	.036	82.2	16.5	>50.0
0:38 p.	53 31	1.24	1.441	1.012	.805	.051	.040	.046	84.1	9.6	9.3
0:55 p.	52 52	1.25	1.414	1.002	.793	.062	.038	.050	81.8	8.7	6.3
4:14 p.	24 17	2.42	1.151	.869	.707	.066	.058	.062	67.4	7.9	3.2
Apr. 9											
2:01 a.	46 14	1.39	1.133	.815	.659	.142	.138	.140	66.6	8.8	4.3
0:28 a.	54 44	1.23	1.196	.818	.670	.114	.176	.145	68.4	6.5	2.8
0:52 p.	53 26	1.24	1.220	.826	.677	.115	.175	.145	70.5	7.4	3.8
Apr. 10											
3:05 a.	36 54	1.66	1.212	.861	.690	.072	.078	.075	72.7	10.0	8.8
1:41 a.	49 05	1.32	1.283	.872	.710	.077	.102	.090	74.4	8.0	4.4
0:39 a.	54 34	1.23	1.310	.911	.719	.074	.071	.072	75.4	7.6	4.7
4:00 p.	27 19	2.17	1.099	.822	.658	.077	.061	.069	67.4	10.5	9.6
Apr. 13											
2:43 a.	46 01	1.39	1.173	.850	.685	.124	.112	.118	70.5	9.7	8.7
Apr. 15											
2:54 a.	40 00	1.55	1.189	.818	.676	.086	.150	.118	72.1	10.4	10.1
Apr. 18											
2:36 a.	43 41	1.45	1.157	.804	.653	.094	.140	.117	69.5	8.8	5.9
2:09 a.	47 47	1.35	1.199	.831	.674	.100	.140	.120	70.5	8.2	4.6
0:50 a.	56 49	1.19	1.217	.830	.653	.087	.105	.096	76.0	13.0	39.0
1:09 p.	55 06	1.22	1.196	.845	.669	.107	.102	.104	74.7	12.5	33.0
3:53 p.	30 33	1.96	.945	.721	.568	.121	.092	.106	64.2	15.1	50.0
Apr. 19											
2:23 a.	45 51	1.39	1.235	.851	.683	.079	.106	.092	73.6	12.5	28.0
2:09 a.	48.02	1.34	1.242	.860	.683	.079	.092	.086	75.1	10.5	13.3
Apr. 21											
2:12 a.	48 11	1.34	1.234	.860	.691	.090	.109	.100	73.2	9.0	6.7
Apr. 22											
3:47 p.	32 12	1.87	1.193	.866	.695	.070	.062	.066	72.2	10.1	6.1
5:05 p.	18 15	3.18	.833	.649	.562	.116	.133	.124	48.7	5.3	1.2
Apr. 25											
2:06 a.	50 08	1.30	1.364	.938	.738	.043	.048	.046	82.1	10.9	13.3
0:19 p.	60 33	1.14	1.384	.932	.717	.044	.025	.034	85.4	13.2	43.0
Apr. 26											
2:14 a.	49 11	1.32	1.276	.883	.699	.071	.079	.075	77.1	10.5	13.3
0:33 a.	60 25	1.15	1.371	.974	.765	.041	.050	.046	83.5	11.9	30.0
0:59 p.	58 34	1.17	1.444	.974	.770	.028	.048	.038	84.3	8.9	7.7
Apr. 28											
1:17 p.	57 25	1.19	1.389	.941	.751	.045	.054	.050	81.3	9.7	10.0
Apr. 29											
3:17 a.	37 40	1.63	1.332	.922	.731	.038	.045	.042	79.2	10.1	9.2
1:20 a.	57 16	1.19	1.390	.950	.748	.049	.050	.050	82.4	9.7	10.0
0:24 p.	61 43	1.13	1.455	1.001	.788	.037	.031	.034	85.5	9.4	9.7
2:28 p.	47 44	1.35	1.365	.934	.748	.045	.072	.058	79.4	8.1	4.5
3:27 p.	37 40	1.63	1.272	.878	.710	.055	.084	.070	74.0	7.5	3.4
Apr. 30											
4:10 a.	30 29	1.96	.900	.653	.547	.143	.186	.164	55.4	8.3	3.9
2:50 a.	45 01	1.41	1.080	.759	.637	.150	.215	.182	63.3	6.8	2.9
0:55 a.	60 12	1.15	1.190	.811	.671	.150	.218	.184	66.9	4.4	1.4
1:11 p.	58 30	1.17	1.149	.801	.670	.164	.233	.198	64.7	4.6	1.6

[1] Reduced to value at mean solar distance.

Notes on sky conditions at Blue Hill

Date and time from apparent noon	Wind	Visibility	Sky blueness	Clouds, etc., and remarks
April 1934				
2, 2:57 p	SW&W		3	Few Ci.; moderate haze.
3, 1:01 p	NNW 4-5		3	Few Ci.; mod. hz. & smk.
3, 2:42 p	NNW 5	8	4	Smoke in valley.
5, 2:20 a	N 3-4	8-9	3	City smk. in NW & SW.
5, 0:47 p	NE&N 2	8	4	0 clds.; mod. hz. in SW & W.
5, 3:13 p	NE&N 1-2		4	Smk. & hz. in SW & W.
5, 3:29 p	ENE 1		3	Mod. hz.
8, 2:05 a	N&NW 5-6			Mod. hz.; 2 Cu Stcu. & Frcu. interfered.
8, 0:54 p	NW 5		4	3 Cu., Frcu. (not near sun).
8, 2:50 p	NW 3	10	4	Few Ci., Cu., Frcu.; very clear.
9, 1:42 a	WNW 6		4	0 clds.; mod. hz.; harbor invisible.
9, 0:47 p	W 7	7	4	Few Ci., Cu. (possibly Ci. over sun).
9, 2:56 p	W 7		4	Few Ci., Cu.; thin Ci. over sun.
10, 1:31 a	ESE 3		4	Few Ci.; mod. hz.
10, 0:53 p	ENE 4	8	4	Few Cist.; in W & N visibility 7.
10, 3:52 p	NE 5	8	4	Few Cist.; (hz. & smk.; reduced vis. in W.)
11, 2:03 a	NE 4		4	Ci. coming on rapidly; hz. over Boston.
15, 2:26 a	NW&N 1-2		3	Cu. & Frcu. forming rapidly.
18, 2:19 a	NW&W 2		3	Lt. hz.; excellent sky.
18, 0:58 p	E 1			No clds.
18, 3:49 p	W 3		3	Few Cist.; some smk. in W & SW.
19, 2:16 a	SSE 4		3	Few Acu.
21, 2:27 a	NW&N 2		3	Few Frcu. & Cu. near sun.
22, 3:53 p	NW 6	8	3	Few Frcu. & Cu. in E.
24, 0:46 p	SSW 9		6	Few Cu., Frcu.
24, 3:58 p	S 9		4	Few Ci., Acu., Cu.; poor conditions.
25, 2:10 a	W 4-5	8	4	0 clouds.
25, 0:42 p	NW&W 4		4	Few Ci., Cist. (clouds stopped obs'ns.).
26, 1:55 a	SW 3-4	8	4	Cist. in N; conditions good.
29, 3:01 a	NW 2	9	4	0 clouds.
29, 0:23 p	SW&W 2		4	0 clouds; conditions good.
29, 3:22 p	SE&S 2		6	Do.
30, 3:00 a	SW&S 4-5		4	0 clouds; conditions excellent.
30, 1:05 p	SW&S 5-6	8	4	Ci. low in S & SW; lt. hz.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U.S. Navy, Superiptendent U.S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time		Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1934	h.	m.	°	°	°				
Apr. 1	11	58	No spots						U.S. Naval.
Apr. 2	11	7	No spots						U.S. Naval.
Apr. 3	11	20	+30.0	187.1	+29.0		46	46	U.S. Naval.
Apr. 4			No spots						Harvard.
Apr. 5	11	34	No spots						U.S. Naval.
Apr. 6	11	14	No spots						U.S. Naval.
Apr. 7	14	1	No spots						U.S. Naval.
Apr. 8	11	10	No spots						U.S. Naval.
Apr. 9			No spots						Harvard.
Apr. 10	11	12	No spots						U.S. Naval.
Apr. 11	9	45	No spots						Mount Wilson.

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1934	h.	m.	°	°	°				
Apr. 12	9	30	No spots						Mount Wilson.
Apr. 13	9	50	No spots						Mount Wilson.
Apr. 14	11	31	No spots						U.S. Naval.
Apr. 15	11	5	−80.0	278.9	−28.5		185	185	U.S. Naval.
Apr. 16	14	3	−67.0	277.0	−28.5		309	309	U.S. Naval.
Apr. 17	12	40	−53.0	278.7	−29.8		1320	1320	Harvard.
Apr. 18	11	6	−42.0	277.3	−29.0		710	710	U.S. Naval.
Apr. 19	12	40	−26.8	278.5	−30.0		950	950	Harvard.
Apr. 20	10	13	−16.0	277.3	−29.0		617	617	U.S. Naval.
Apr. 21	11	2	{−10.5	269.2	−29.5		93		U.S. Naval.
			−0.5	279.2	−28.0	432		525	U.S. Naval.
Apr. 22	11	0	{+1.5	268.0	−29.5		93		U.S. Naval.
			+12.5	279.0	−29.0	432		525	U.S. Naval.
Apr. 23	11	1	{+12.5	265.8	−29.5		31		U.S. Naval.
			+25.5	278.8	−29.0	432		463	U.S. Naval.
Apr. 24	11	5	+39.0	279.0	−29.0	340		340	U.S. Naval.
Apr. 25	11	8	+51.0	277.8	−29.0	340		340	U.S. Naval.
Apr. 26	13	11	+64.5	276.9	−29.0	309		309	U.S. Naval.
Apr. 27	9	50	{+26.0	227.0	+27.0		12		Mount Wilson
			+76.0	277.0	−29.0	590		602	Mount Wilson.
Apr. 28	11	1	No spots						U.S. Naval.
Apr. 29	12	58	No spots						U.S. Naval.
Apr. 30	10	44	No spots						U.S. Naval.
Mean daily area for 30 days								241	

NOTE.—Harvard Observatory reported that there were no spots on Feb. 19, 1934.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR APRIL 1933

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgenössische Sternwarte, Zurich, Switzerland]

April 1934	Relative numbers	April 1934	Relative numbers	April 1934	Relative numbers
1	0	11	0	21	22
2	11	12	0	22	*b* 18
3	12	13	0	23	16
4	9	14	*d* 7	24	19
5	8	15	21	25	11
6	0	16	33	26	10
7	0	17	32	27	16
8	0	18	29	28	14
9		19	22	29	7
10	0	20	21	30	0

Mean: 29 days=11.7.

b=Passage of a large group or spot through the central meridian.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. Little, in Charge]

By L. T. SAMUELS

Free-air temperatures during April averaged above normal in practically all cases except at Pembina and Washington, where appreciable negative departures prevailed (table 1). Relative humidity departures for the month were small except at Norfolk, where large positive values obtained in the higher levels.

Resultant free-air wind directions for the month were close to normal in practically all cases. Resultant free-air velocities were mostly above normal except in the west where they were generally less than normal.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during April 1934*

TEMPERATURES (°C.)

Altitude (meters) m.s.l.	Boston, Mass.[1] (6 meters)		Cleveland, Ohio[2] (246 meters)		Dallas, Tex.[3] (146 meters)		Norfolk, Va.[4] (3 meters)		Omaha, Nebr.[5] (300 meters)		Pembina, N.-Dak.[6] (243 meters)		San Diego, Calif.[4] (5 meters)		Washington, D. C.[4] (2 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	7.1	(7)	4.3	(7)	15.4	(7)	13.1	+1.1	7.0	(7)	0.3	(7)	17.2	+0.4	8.9	−2.0
500	5.3	(7)	5.5	(7)	16.5	(7)	12.8	+1.2	7.9	(7)	1.1	(7)	14.4	+0.6	8.4	−0.4
1,000	3.5	+1.7	4.7	−0.7	15.4	+2.1	11.1	+1.6	7.6	+2.0	−0.5	−2.4	15.8	+3.0	6.3	−0.4
1,500	2.0	+2.6	3.0	−0.1	13.2	+1.4			5.4	+1.8	−2.8	−2.3				
2,000	−0.3	+2.2	0.4	−0.4	11.3	+1.7	5.8	+1.1	2.6	+1.3	−5.4	−2.3	12.3	+3.2	1.2	−2.1
2,500	−2.7	+1.8	−1.8	−0.1	8.6	+1.7			−0.2	+1.1	−7.5	−1.5				
3,000	−5.2	+1.6	−3.9	+0.3	4.9	+1.0	−0.5	0.0	−3.1	+1.0	−9.7	−0.7	5.8	+2.6	−1.3	−2.0
4,000	−10.1		−9.1	+0.3	−2.9	−0.5			−8.5	+1.7	−14.3	+0.6	−0.6	+2.4		
5,000	−16.2		−14.9		−10.8	−2.6			−15.5	+0.6	−20.6	+0.6				

RELATIVE HUMIDITY (PERCENT)

Altitude (meters) m.s.l.	Boston Mean	Boston Departure	Cleveland Mean	Cleveland Departure	Dallas Mean	Dallas Departure	Norfolk Mean	Norfolk Departure	Omaha Mean	Omaha Departure	Pembina Mean	Pembina Departure	San Diego Mean	San Diego Departure	Washington Mean	Washington Departure
Surface	72	(7)	78	(7)	84	(7)	72	+7	62	(7)	86	(7)	68	+1	71	+8
500	68	(7)	72	(7)	72	(7)	63	+7	61	(7)	73	(7)	72	−1	65	+6
1,000	63	−4	65	+3	62	+1	62	+10	56	−6	69	+8	50	−10	65	+8
1,500	60	−8	58	−2	57	+9			53	−6	65	+7				
2,000	60	−7	56	−2	50	+7	64	+16	50	−7	63	+7	32	−6	63	+7
2,500	61	−7	55	+1	44	+3			49	−8	58	+3				
3,000	61	−7	53	+2	45	+6	66	+21	49	−7	54	−1	28	+1	56	+6
4,000	54		51	+3	46	+4			48	−7	47	−9	24	+2		
5,000	51		47	0	45	+7			48	−4	48	−6				

Times of observations: Weather Bureau, 5 a.m.; Navy, 7 a.m.; and Massachusetts Institute of Technology, 8 a.m., eastern standard time.

[1] Airplane observations made by Massachusetts Institute of Technology; departures based on normals obtained from 264 kite observations made at Blue Hill Meteorological Observatory (1896–1903).

[2] Temperature departures based on normals determined by extrapolating latitudinally those of Royal Center, Ind., and Due West, S.C. Humidity departures based on normals of Royal Center, Ind.

[3] Temperature departures based on normals determined by interpolating latitudinally those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.

[4] Naval air stations.

[5] Temperature and humidity departures based on normals of Drexel, Nebr.

[6] Temperature departures based on normals determined by extrapolating latitudinally those of Ellendale, N.Dak., and Drexel, Nebr. Humidity departures based on normals of Ellendale, N.Dak.

[7] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 7 a.m. (eastern standard time) during April 1934*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m.s.l.	Albuquerque, N. Mex. (1,554 meters)		Atlanta, Ga. (309 meters)		Bismarck, N.Dak. (518 meters)		Brownsville, Tex. (7 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (192 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	24	1.0	270	1.2	315	2.1	121	1.2	191	1.7	292	3.6	243	1.5	205	1.8	155	2.1	256	0.4	274	1.0	86	1.5
500			265	5.0			151	7.0	216	3.7			252	5.9	236	5.5	192	4.3			253	3.4	109	3.4
1,000			276	7.9	316	7.1	167	6.5	238	4.8			267	7.6	257	8.5	230	4.8	254	2.4	252	3.7	132	3.0
1,500			273	8.4	320	11.4	175	5.8	252	6.7			277	7.8	264	9.0	270	4.3	285	5.2	264	5.8	153	2.0
2,000	221	.7	278	9.6	316	14.2	186	4.6	259	6.8	288	4.8	279	8.8	264	10.5	291	5.5	303	6.4	271	6.2	191	2.8
2,500	271	3.5	276	8.6	314	14.2	204	3.7	279	8.1	303	5.1	291	8.9	267	12.3	298	6.4	300	8.0	266	7.4	214	2.9
3,000	281	4.5	281	9.2	322	15.6	229	2.0	264	8.2	310	5.7	293	11.9	268	11.5	309	7.4	297	9.1	268	7.8	246	3.4
4,000	294	5.8	282	9.0			291	2.8	300	8.5	310	9.2			284	12.5	321	5.8	317	8.2	273	7.8	265	6.2
5,000	294	6.0	268	10.0			287	3.8			325	8.5							326	5.3	278	9.0	267	6.7

Altitude (meters) m.s.l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (83 meters)		New Orleans, La. (19 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (402 meters)		Omaha, Nebr. (306 meters)		Phoenix, Ariz. (338 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D.C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	134	0.8	253	0.4	260	0.5	67	1.5	85	0.7	132	1.2	228	0.4	85	1.8	143	2.9	56	0.5	164	0.8	268	0.3
500	88	.7	286	.7	253	4.1	193	1.2	301	2.8	179	1.5	253	2.7	64	.7			190	.9	224	.6	270	3.3
1,000	9	2.0	287	1.3	258	5.8	291	1.5	313	3.6	227	2.4	277	4.9	286	1.7			258	4.4	170	.8	285	4.9
1,500	347	2.4	132	.6	260	8.2	254	2.4	329	5.0	291	3.2	286	6.5	278	1.7	160	3.5	257	7.0	218	1.1	281	7.9
2,000	319	2.4	187	1.3	272	8.6	261	4.2	334	6.2	300	5.6	288	8.5	257	1.9	197	2.0	271	7.4	228	2.4	273	9.0
2,500	330	2.5	210	1.9	291	8.4	283	7.8	314	6.6	303	7.8	301	9.7	223	1.7	237	.8	268	8.8	234	3.1	276	9.7
3,000	344	3.8	209	2.6	299	7.3	282	10.0	309	5.7	300	8.4	291	10.9	202	2.1	315	1.0	273	9.4	226	3.2	281	10.4
4,000	327	4.9	205	3.0	283	4.9	311	9.8	308	7.6	308	6.6			222	2.1	304	4.0			235	4.9	276	6.7
5,000	289	8.6					305	5.1							282	4.6	314	4.2			211	5.9		

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, MONTROSE W. HAYES, in charge]

The official in charge of the Weather Bureau office at Houston, Tex., comments as follows on the flood in the Sabine River in March:

Moderately heavy rains were general over the upper drainage basin of the Sabine River from February 8 to 11, inclusive, and again on February 18. The run-off brought the Sabine River at Logansport from a stage of 7.7 feet on February 8 to a crest of 16.3 on February 22. Heavy rains fell over the entire drainage basin of the Sabine River on February 28 and continued on March 1 and 2. This downpour, falling on soil already very wet, produced rapid run-off. The river rose rapidly to flood stage on March 3 and reached a crest of 28.4 on March 8.

Damage was estimated by the river observer at $410,000. The greater portion of this was crop loss, and for that reason problematical. However, the estimate was made with deliberation after the flood had receded, and it is the best information available to us.

There were numerous floods in the United States in April but, except for the ones in the Connecticut River, the upper Mississippi Valley, and in Oklahoma, none were of importance.

During the last days of March there was a heavy snowfall over the northern and central part of Wisconsin and southeastern Minnesota. Partial melting of this snow caused rises in all streams. On April 2 and 3 heavy rains fell in most of the same territory melting the remainder of the snow. The rainfall ranged from 2 to 4 inches and as the ground was frozen the run-off was exceptionally rapid.

Twelve people lost their lives in the flood waters and many were compelled to leave their homes, while others narrowly escaped drowning when trapped on flooded highways or weakened bridges. The total damage exceeded $1,000,000.

In this flood the damage was caused almost entirely by small streams, in fact, flood stages were reached at only two of the Weather Bureau's gages in this region.

Torrential rains in western Oklahoma on April 4 caused a disastrous flood in the Washita River. This flood came on suddenly in the night and 22 persons lost their lives. The damage was somewhat more than $500,000. No flood service is maintained on the Washita River.

The flood in the Connecticut River will be commented on in a later issue of the MONTHLY WEATHER REVIEW.

Table of flood stages during April 1934

[All dates in April unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE	*Feet*			*Feet*	
Red Cedar: Williamston, Mich	6	4	4	6.5	4
Flint: Columbiaville, Mich	8	4	6	9.8	6
ATLANTIC SLOPE DRAINAGE					
Connecticut:					
White River Junction, Vt	18	13	14	20.5	13
		17	22	19.3	21
		26	27	18.8	26-27
Holyoke, Mass	9	13	15	10.3	14
Hartford, Conn	16	3	7	18.9	5
		13	24	23.1	14
		27	28	16.4	28
Roanoke:					
Weldon, N.C	31	10	13	39.3	11
Williamston, N.C	10	11	27	11.5	17

Table of flood stages during April 1934—Continued

[All dates in April unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE—continued	*Feet*			*Feet*	
Fishing Creek: Enfield, N.C	14	12	(1)	(1)	(1)
Tar:					
Rocky Mount, N.C	8	11	14	10.9	14
Tarboro, N.C	18	14	17	21.0	16
Greenville, N.C	12	2	4	13.0	3
		13	23	15.5	17-18
Neuse:					
Neuse, N.C	13	10	14	19.0	12
		19	20	14.5	20
Smithfield, N.C	12	10	16	18.0	15
		20	21	13.8	21
Haw: Moncure, N.C	19	10	10	24.5	10
Cape Fear: Fayetteville, N.C	35	11	11	35.3	11
Peedee: Mars Bluff Bridge, S.C	17	14	15	17.4	15
Santee:					
Rimini	12	11	13	12.8	12
		21	23	14.0	22
		25	29	13.0	28
Ferguson, S.C	12	1	4	12.3	3
Savannah: Ellenton, S.C	14	20	22	15.3	21
MISSISSIPPI SYSTEM					
Upper Mississipi Basin					
Chippewa: Durand, Wis	11	4	7	12.4	4
Wisconsin: Knowlton, Wis	12	5	6	13.3	6
Ohio Basin					
Wabash: LaFayette, Ind	11	1	1	11.4	1
Ohio: Dam No. 52	35	3	4	35.1	3-4
White Basin					
Black: Black Rock, Ark	14	7	7	14.3	7
White:					
Georgetown, Ark	21	Mar. 28	17	24.5	1
Clarendon, Ark	26	Mar. 30	25	29.8	6-8
Arkansas Basin					
North Canadian: Canton, Okla	6	4	4	8.5	4
Petit Jean: Danville, Ark	20	6	8	21.7	28
Red Basin					
Ouachita:					
Arkadelphia, Ark	12	6	6	12.9	6
Camden, Ark	26	7	12	30.7	10
Little: Whitecliffs, Ark	25	9	11	25.3	11
Sulphur:					
Ringo Crossing	20	6	10	25.3	7
		17	17	21.8	17
Naples, Tex	22	9	16	26.0	10
		29	May 1	22.7	30
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark	10	Mar. 27	20	16.0	2
St. Francis:					
Fish, Mo	20	8	10	21.9	9
St. Francis, Ark	18	1	5	18.5	3-4
Atchafalaya Basin					
Atchafalaya: Atchafalaya, La	22	7	23	22.7	15-17
WEST GULF OF MEXICO DRAINAGE					
Sabine: Logansport, La	25	10	16	26.4	12
Trinity:					
Trinidad, Tex	28	8	13	32.9	11
Long Lake, Tex	40	12	15	40.9	13
Liberty, Tex	25	7	23	27.3	11-13
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Clearwater: Kamiah, Idaho	12	24	25	12.1	24-25
Columbia:					
Marcus, Wash	24	21	(2)	(2)	(2)
Vancouver, Wash	15	29	(2)	(2)	(2)

[1] Unknown, gage washed away.
[2] Flood continued into May.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, WILLIS E. HURD, acting in charge]

NORTH ATLANTIC OCEAN

By HERBERT C. HUNTER

Atmospheric pressure.—The mean pressure of April 1934 was lower than normal over most of the North Atlantic, though it was higher than normal over the north-central and northwestern portions, particularly near Labrador and Newfoundland.

There was a marked contrast in pressure conditions during the first and second halves of the month. From April 1 to 15, inclusive, pressure averaged about 0.5 inch greater than normal at Reykjavik, Iceland, and about 0.6 inch less than normal at Horta, Azores. The tendencies from the 16th onward at these stations were the reverse of those for the first half, but the departures from normal were only about one-half as large.

The lowest reading at any of the selected shore stations was 28.90 inches, at Julianehaab, Greenland, on the 27th. During the period 3d to 6th three vessels reported readings slightly lower than this. The first of these in time was noted but a short distance northeast of Horta; the other two were noted considerably farther to westward, and were near each other in both time and location; of these two, the reading of the American steamship *Padnsay*, at 5:30 a.m. of the 6th, is the lowest pressure yet reported from any part of the North Atlantic Ocean during the month, namely, 28.75 inches, in latitude 37°23′ N., longitude 48°38′ W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, April 1934*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.99	--------	30.44	3, 5	28.90	27
Reykjavik, Iceland	29.94	+0.14	30.67	4	29.01	30
Lerwick, Shetland Islands	29.79	-.01	30.40	2	29.17	16
Valencia, Ireland	29.75	-.14	30.25	30	29.30	25
Lisbon, Portugal	29.93	-.06	30.19	21	29.43	1
Madeira	30.00	-.01	30.29	22	29.67	10
Horta, Azores	30.00	-.15	30.64	22	29.26	9
Belle Isle, Newfoundland	30.11	+.28	30.48	1	29.58	26
Halifax, Nova Scotia	30.05	+.12	30.66	30	29.68	21
Nantucket	30.01	+.04	30.70	30	29.33	12
Hatteras	30.00	-.01	30.51	29	29.35	11
Bermuda	30.05	-.04	30.34	30	29.60	11
Turks Island	30.03	+.01	30.10	2, 5	29.90	13
Key West	30.00	-.02	30.16	2	29.73	12
New Orleans	30.02	+.02	30.29	30	29.62	15
Cape Gracias, Nicaragua	29.90	+.01	29.98	1, 19, 20	29.86	4, 5, 11, 12, 13, 16, 17

NOTE.—All data based on a.m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—Gales were decidedly fewer in number in April than was the case during any previous month of the year. No occurrence of a force-12 storm has yet been reported. There were especially few storms during the last 12 days of the month, while the 12-day period next before that included a very large portion of the month's storms especially of those that exceeded force 9. It is notable that the eastern half of the Atlantic was the main region of storm occurrence, as had been the case during March.

A low-pressure area noted south of Newfoundland on the 3d made slow progress eastward for several days, but developed much strength by the 7th. Charts VIII and IX present the situations on the 7th and 8th, when this storm was centered a moderate distance toward the west-northwest from the Azores, while high pressure prevailed over Greenland and Iceland, as had been the case since April began. It was on the 8th that there occurred the sole instance yet reported of a wind of force 11 in the Atlantic area this month, the German motor vessel *Skagerrak*, from Port Arthur to Antwerp, noting this force while near latitude 37° N., longitude 49° W.

By the 11th the storm center mentioned had reached the Bay of Biscay in its eastward advance, but a following low-pressure area had attained considerable development between Newfoundland and the Azores, and by the 12th was still better developed just north of the Azores. At this time unusually high pressure covered Newfoundland, Labrador, southern Greenland, adjacent waters, and the northern part of Hudson Bay; while still another marked area of low pressure was centered near New York City, and was strongly affecting coastal nearby waters. High winds occurred at this time in the northeastern portion of the United States, an extraordinarily high velocity being noted at the station on the summit of Mount Washington, N.H. The conditions on the 11th and 12th appear on charts X and XI.

Behind the low-pressure area over the northeastern part of the United States there was high pressure over the Plains. This situation favored the carrying of dust or fine sand over the Gulf of Mexico, some of which was noted as deposited on the 12th on the steamship *William Boyce Thompson*, then about 120 miles south-southeastward of South Pass, La., the winds experienced being from northwest to north. The same vessel reported that quite a few land birds of different kinds were near the ship during the forenoon of the next day.

A press dispatch states that on the night of the 13th a severe local storm struck the coast region of Mexico south of Vera Cruz. At this writing no information has come to indicate that any vessel in the southwestern part of the Gulf of Mexico encountered this storm, and it is thought that it was of very small extent. Fresh gales were experienced, however, near the Yucatan Channel, on the 17th, and not far from the western coast of Louisiana on the 19th.

Fog.—While fog was of infrequent occurrence to southward of Cape Hatteras, it occurred often in the vicinity of the coast between Capes Hatteras and Cod, where it was for the most part about as frequent as it had been during the preceding March. Here the middle decade of the month was the time of most frequent prevalence, while the final decade was almost wholly free from fog.

From Cape Cod eastward to mid-Atlantic fog was more prevalent than it had been during the month preceding and occurred considerably oftener than is usual during April. The square between parallels 40° and 45° north, meridians 45° and 50° west, is indicated as the area of most frequent occurrence, as reports show fog there on 18 days; there and in the adjoining 5° squares to northward or westward the portion of the month with fog least prevalent was about the 9th to 17th.

From the 40th meridian eastward to European waters there was little fog. In particular, there has come as yet only a single report of any occurrence of fog during the month within the area bounded by parallels 35° and 50° north, meridians 10° and 30° west, though normally fog is encountered in most of this area on from 1 to 3 April days.

There were a few accidents to vessels caused by collision or grounding due to fog during April in Atlantic waters, but they were of comparative unimportance.

OCEAN GALES AND STORMS, APRIL 1934

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Black Tern, Am.S.S.	Antwerp	New York	49 08 N.	27 34 W.	Apr. 2	2p, Apr. 1	Apr. 2	29.68	N	N, 6	NNW	N, 9	SE-SW-N.
West Quechee, Am.S.S.	New Orleans	Havre	48 21 N.	26 59 W.	Apr. 1	6a, 2	Apr. 4	29.65	N	ESE, 6	E	NNW, 10	NNW-ESE-E
Benekom, Du.S.S.	Curacao	Liverpool	43 03 N.	27 29 W.	do	8a, 2	Apr. 2	[2] 29.29	NNW	NNW, 9	N	NNW, 10	None.
City of Joliet, Am.S.S.	Rotterdam	Tampa	30 18 N.	36 40 W.	Apr. 2	8a, 3	Apr. 3	30.02	NW	NNW, 6	NW	NW, 8	Do.
Winnipeg, Fr. S.S.	Havre	Cristobal	39 27 N.	25 32 W.	Apr. 3	4p, 3	Apr. 4	28.84	SW	SSW, 6	WNW	WSW, 8	S-SW
Padrsay, Am.S.S.	New York	Teneriffe	37 23 N.	48 38 W.	Apr. 6	6a, 6	Apr. 7	28.75	SE	SSW, 9	WSW	WSW, 10	SE-WSW.
Emanuel Nobel, Belg. S.S.	do	Liverpool	50 46 N.	18 12 W.	Apr. 1	11a, 6	do	29.65	NNW	NNE, 9	NNE	ENE, 10	None.
City of Joliet, Am.S.S.	Rotterdam	Tampa	27 40 N.	51 30 W.	Apr. 7	4a, 7	do	29.74	WNW	W, 6	NW	NW, 8	W-WNW.
Selma City, Am.S.S.	Gibraltar	New York	36 35 N.	8 50 W.	Apr. 8	11a, 7	Apr. 8	29.55	W	WSW, 7	W	W, 8	WSW-W.
Boston City, Br. S.S.	Halifax	Cardiff	45 50 N.	41 24 W.	Apr. 5	3p, 7	Apr. 9	29.41	NNE	E, 10	E	E, 10	Steady.
Memphis City, Am.S.S.	Cristobal	Liverpool	34 10 N.	59 00 W	Apr. 7	5p, 7	Apr. 7	29.90	NW	NW, 8	NW	NW, 8	None.
De la Salle, Fr. S.S.	Vigo	Guadeloupe	33 30 N.	35 00 W.	do	1a, 8	Apr. 9	[2] 29.41	SW	SW, 7	WNW	WSW, 8	SW-W-WSW.
Skagerrak, Ger.M.S.	Port Arthur	Antwerp	37 03 N.	48 45 W.	do	4a, 8	Apr. 10	29.35	WNW	NW, 11	WNW	NW, 11	NW-NNW.
Selma City, Am.S.S.	Gibraltar	New York	36 45 N.	20 10 W.	Apr. 9	2a, 10	do	29.27	SW	SW, 8	W	SW, 8	SW-W.
Pres. Harding, Am.S.S.	Cobh	do	44 47 N.	44 12 W.	do	10a, 10	do	29.45	ENE	W, 6	E	E, 9	E-W.
Meanticut, Am.S.S.	New Orleans	Bremen	37 40 N.	67 48 W.	Apr. 11	2a, 11	Apr. 13	29.50	ENE	ENE, 8	ESE	ENE, 8	ENE-NE-ENE.
Memphis City, Am.S.S.	Cristobal	Liverpool	42 30 N.	42 20 W.	do	3p, 11	do	29.33	E	E, 10	NNE	E, 10	E-NE.
Selma City, Am.S.S.	Gibraltar	New York	37 01 N.	30 15 W.	do	10a, 12	Apr. 12	29.40	W	W, 7	W	W, 10	
Berlin, Ger.S.S.	New York	Galway	40 45 N.	66 32 W.	Apr. 12	Noon, 12	do	29.57	SSE	SE, 9	ESE	SSE, 10	SSE-ESE.
Skagerrak, Ger.M.S.	Port Arthur	Antwerp	41 24 N.	27 40 W.	Apr. 11	4p, 12	Apr. 13	28.92	SW	SW, 10	NNW	SW, 10	SW-WNW.
Hubert, Br.S.S.	Leixoes	Liverpool	43 38 N.	9 16 W.	Apr. 13	1p, 13	Apr. 14	29.74	S	SSW, 9	SSW	S, 10	S-SSW.
Chester Valley, Am.S.S.	Oran, Algeria	Galveston	31 52 N.	25 48 W.	Apr. 14	5a, 14	do	29.56	SW	SW, 8	W	SW, 8	SW-W.
Yoseric, Br. S.S.	Huelva	Baltimore	35 45 N.	20 55 W.	do	1p, 14	do	29.52	SSW	SW, 9	SW	SW, 9	SSW-SW.
Skagerrak, Ger.M.S.	Port Arthur	Antwerp	44 47 N.	19 00 W.	do	10p, 14	Apr. 15	29.20	N	N, 9	NNW	N, 9	N-NNW.
Barneveld, Du.S.S.	Cristobal	Liverpool	41 12 N.	39 05 W.	Apr. 17		Apr. 17		NW		NNW	NW, 9	NW-N.
Oakman, Am.S.S.	Antwerp	Galveston	48 23 N.	14 14 W.	Apr. 15	6a, 15	Apr. 15	29.07	SSE	S, 9	SW	SSW, 9	SE-SW.
Chilbar, Am.S.S.	Baltimore	New Orleans	[1] 35 15 N.	[1] 75 10 W.	do	4p, 15	do	[2] 29.87	S	S, 10	S	S, 10	
Blankaholm, Swed.M.S.	Galveston	Dunkirk	40 50 N.	57 24 W.	do	4a, 16	Apr. 16	29.76	NW	NW, 9	NNW	NW, 9	Steady.
Stuttgart, Ger.S.S.	Galway	Halifax	52 30 N.	22 18 W.	Apr. 16	4p, 16	Apr. 17	29.13	N	N, 7	NW	NNW, 10	SE-N-NNW.
Baja California, Hond. S.S.	Bluefields	New Orleans	18 18 N.	84 42 W.	Apr. 18	6a, 17	Apr. 18	29.89	ENE	ESE, 4	NE	NE, 8	None.
Pacific Sun, Am. M.S.	Philadelphia	Port Arthur	29 04 N.	92 07 W.	Apr. 19	10a, 19	Apr. 19	30.06	NW	NW, 8	NW	NW, 8	SW-NW-N.
Cameronia, Br.S.S.	Moville	New York	55 00 N.	15 59 W.	Apr. 23	Noon, 23	Apr. 24	29.50	W	WNW, 8	W	WNW, 8	W-WNW
Capulin, Am.S.S.	Dundee	Boston	57 30 N.	22 48 W.	Apr. 25	4a, 25	Apr. 25	29.24	NNW	NW, 5	NW	NNW, 8	NW-NNW.
Santa Lucia, Am.S.S.	Cristobal	New York	[1] 28 30 N.	[1] 79 18 W.	Apr. 30	8p, 30	May 1	30.13	ENE	ENE, 8	E	ENE, 8	NE-ENE.
NORTH PACIFIC OCEAN													
Hikawa Maru, Jap. S.S.	Yokohama	Vancouver	45 01 N.	162 30 E.	Mar. 31	4a, Mar. 31	Apr. 1	27.94	S	SSW, 8	W	W, 10	S-SW-W.
Empress of Asia, Br. S.S.	Vancouver	Yokohama	49 36 N.	171 12 E.	do	8p, 31	Apr. 2	28.05	SSE	S, 9	W	WNW, 11	S-SW-W.
Koyo Maru, Jap. S.S.	Yokohama	Los Angeles	36 50 N.	156 40 E.	Apr. 1	5a, 2	do	29.38	S	SSW, 8	WSW	SSW, 8	SSW-SW.
Taiyo Maru, Jap. S.S.	do	Honolulu	34 10 N.	160 15 E.	Apr. 2	8a, 2	do	29.82	SE	S, 8	SW	SSW, 9	SE-S-SSW.
Empress of Asia, Br. S.S.	Vancouver	Yokohama	[1] 46 05 N.	[1] 158 43 E.	do	4p, 2	do	28.96	ENE	ENE, 8	NNW	N, 9	ENE-N-NNW.
Pres. Grant, Am. S.S.	Victoria	do	52 42 N.	159 07 W.	Apr. 3	6a, 4	Apr. 4	29.20	S	SW, 8	W	S, 9	SW-WSW.
Siljestad, Nor. M.S.	Iloilo	Los Angeles	31 30 N.	152 00 E.	Apr. 9	10p, 6	Apr. 10	[2] 30.16	NE	SSW, 4	ESE	NE, 9	SSW-W-N.
Shelton, Am. S.S.	Tacoma	Yokohama	52 04 N.	150 58 W.	Apr. 7	11p, 7	Apr. 8	29.48	SSW	SSW, 8	W	SSW, 9	SSW-W.
Pres. Grant, Am. S.S.	Victoria	do	50 30 N.	179 10 W.	Apr. 5	4p, 7	Apr. 9	29.41	S	S, 6	WNW	W, 11	ESE-S-SW.
Shelton, Am. S.S.	Tacoma	do	51 36 N.	165 32 W.	Apr. 11	2a, 12	Apr. 12	29.47	S	W, 6	S	S, 9	S-W.
Pres. Jackson, Am. S.S.	Yokohama	Victoria	49 30 N.	174 00 W.	Apr. 10	Mdt. 11	Apr. 11	29.46	S	W, 7	SW	SW, 8	None.
Koyo Maru, Jap. S.S.	do	Los Angeles	36 41 N.	146 10 W.	Apr. 11	2a, 12	Apr. 12	29.07	ENE	E, 3	WSW	N, 8	E-NE-N
Shelton, Am. S.S.	Tacoma	Yokohama	51 20 N.	170 14 W.	Apr. 13	6a, 13	Apr. 13	29.40	S	SSW, 9	W	W, 10	S-W.
Tosari, Du. M.S.	Macassar	Los Angeles	38 17 N.	159 08 W.	do	5a, 13	do	[2] 29.70	NW	NW, 8	N	N, 8	NNW-NW-NNW.
Oregon, Am. S.S.	Shanghai	Portland, Oreg.	49 51 N.	169 00 W.	do	8a, 13	do	29.53	SW	SW, 9	SW	SW, 9	None.
Olympia, Am. S.S.	Manila	Los Angeles	36 17 N.	147 02 E.	Apr. 14	3a, 14	Apr. 14	29.80	N	N, 8	N	N, 8	NE-N-NNW.
Shelton, Am. S.S.	Tacoma	Yokohama	50 45 N.	175 20 W.	do	6p, 14	Apr. 15	29.03	SW	WSW, 11	NW	WSW, 11	S-WSW.
Hiye Maru, Jap. M.S.	Yokohama	Vancouver	48 00 N.	173 13 E.	Apr. 15	5a, 15	do	29.30	SW	SW, 8	W	W, 10	SW-W.
Golden Star, Am. S.S.	Siain, P.I.	San Francisco	36 06 N.	152 10 E.	Apr. 17	8p, 17	Apr. 18	29.70	WSW	WSW, 8	NW	W, 9	SW-WSW-W.
Hokuroku Maru, Jap. M.S.	Los Angeles	Yokohama	43 46 N.	141 55 W.	Apr. 18	4a, 18	Apr. 19	29.17	WNW	SSW, 7	NW	WNW, 8	S-W.
Oregon, Am. S.S.	Shanghai	Portland, Oreg.	[1] 49 11 N.	[1] 138 41 W.	do	Noon, 18	Apr. 18	29.29	E	SE, 7	E	E, 9	E-SE.
Olympia, Am. S.S.	Manila	Los Angeles	42 21 N.	164 53 E.	Apr. 17	2p, 18	Apr. 19	29.36	ESE	SW, 8	W	SW, 9	S-SW-WSW.
Tacoma, Am. S.S.	Tsingtao	Seattle	48 00 N.	163 35 E.	Apr. 18	7p, 18	do	28.61	WNW	SSW, 4	W	WNW, 10	S-W.
Shelton, Am. S.S.	Tacoma	Yokohama	49 18 N.	172 54 E.	do	3a, 19	do	28.68	ESE	SW, 9	W	WSW, 12	SSW-W.
Siljestad, Nor. M.S.	Iloilo	Los Angeles	40 50 N.	140 40 W.	do	3a, 20	Apr. 20	[2] 29.88	NW	W, 8	WSW	W, 9	WNW-WSW.
Frank G. Drum, Am.S.S.	La Union	do	14 30 N.	95 30 W.	Apr. 21	10p, 21	Apr. 22	29.85	N	N, 8	NW	N, 8	
Pres. Jefferson, Am. S.S.	Yokohama	Victoria	37 27 N.	144 23 E.	do	2p, 22	do	29.53	NNW	NW, 9	NW	NW, 9	None.
Golden Star, Am. S.S.	Siain, P.I.	San Francisco	45 26 N.	156 50 W.	Apr. 26	2p, 26	Apr. 27	29.69	WNW	WNW, 8	WNW	WNW, 9	None.
New Westminster City, Br. S.S.	Philippines	Los Angeles	35 20 N.	169 52 E.	Apr. 28	6p, 28	Apr. 28	[2] 29.49		S, 8	S	S, 8	S-SSW.
Fernhill, Nor. M.S.	Manila	do	36 25 N.	148 10 E.	Apr. 30	4p, 30	May 1	29.38	S	S, 8	NNW	W, 9	S-WSW.

[1] Position approximate.

[2] Barometer uncorrected.

NORTH PACIFIC OCEAN, APRIL 1934

By Willis E. Hurd

Atmospheric pressure.—Pressure was abnormally low over the Aleutian region during April 1934, with the departure from average at St. Paul Island as great as 0.29 inch. The average barometers at this station and Dutch Harbor were 29.53 and 29.50 inches, respectively, both of which readings were considerably lower than the averages for the previous month.

The North Pacific anticyclone this month was central in the neighborhood of Midway Island, where the average pressure was 30.27 inches, or 0.15 inch above the normal. There was absence of the average winter-type anticyclone over the East China Sea, showing that spring conditions of pressure had set in over middle and lower waters of the Far East.

The lowest barometer reading of the month reported was 28.61 inches, read on the American S.S. *Tacoma,* in 48°00′ N., 163°35′ E., on the 18th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, Apr. 1934, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	30.05	−0.04	30.54	28, 29	29.48	1
Dutch Harbor	29.53	−.25	30.26	6	28.70	3
St. Paul	29.50	−.29	30.14	5, 24	28.72	3
Kodiak	29.65	−.10	30.30	13	28.80	15
Juneau	29.99	+.03	30.44	13	29.22	9
Tatoosh Island	30.08	+.08	30.42	2	29.70	22
San Francisco	30.01	−.04	30.14	25	29.79	14
Mazatlan	29.92	+.03	29.98	1, 28, 30	29.84	13
Honolulu	30.05	−.01	30.19	29	29.82	9
Midway Island	30.27	+.15	30.40	7	30.08	26
Guam	29.91	+.02	29.98	29	29.84	21
Manila	29.82	−.08	29.94	8	29.74	27
Naha	29.97	+.05	30.24	8	29.66	28
Chichishima	30.00	+.03	30.34	8	29.74	27
Nemuro	29.89	----------	30.54	10	29.12	24

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—The rather unusual occurrence of abnormally low pressure in higher middle latitudes accompanied by abnormally high pressure in lower mid-ocean during April, would seem to have resulted in much stormy weather along the central parts of the trans-Pacific steamer routes. Yet this central region, except to the immediate south of the Aleutian Islands, and for a brief period south of Midway Island, is indicated by reports to have been free from gales. The high winds south of Midway were of force 8 to 10 from the northeast, on the 5th and 6th, and resulted from a strong local intensification of the trades.

The stormiest weather of the month occurred south and southwest of the Aleutian Islands. At the close of March a deep cyclone, with lowest pressure about 28 inches, lay between 45° and 50° N., 160° to 170° E., with forces of 10 to 11 encountered over a considerable surrounding area. The storm decreased in depth on April 1, but with the storm forces of the previous day continuing.

On the 8th another cyclone from the westward entered this area and caused further gales, reported as high as force 11, near the 50th parallel, between 175° W. and approximately 170° E. Gales of force 11 likewise occurred near 49° N., 175° W., on the 14th, during a stormy period lasting from the 13th to 15th in Aleutian waters.

On the 17th and 18th stormy weather, with gales of force 9 to 10, set in to the eastward of Japan. By the 19th the storm area had traveled north and northeast, with high wind velocities, which attained a maximum force of 12, lowest barometer 28.68 inches, near 49° N., 173° E. The gale field on this day extended roughly between longitude 175° W. and the Kuril Islands. Thereafter storm conditions in this vicinity rapidly lessened in intensity.

In middle latitudes, between longitude 170° E. and Japan, gales of force 8 to 9 were reported on 10 days, mostly related to cyclones originating over Asia or in adjacent waters.

Two depressions of note originated to the eastward of the Hawaiian Islands in April and slowly moved northward until they coalesced with depressions overlying the northeastern part of the ocean. The first caused fresh gales between 35°–40° N., 145°–160° W., on the 11th to 13th, and the second, fresh to strong gales between 40°–50° N., 135°–150° W., on the 18th to 20th.

Tropical gales.—Weather was generally quiet in the tropics during April and the only high winds worthy of note were a moderate monsoon gale encountered in the Taiwan Channel on the 13th and a Tehuantepecer of force 8 in Mexican waters on the 21st.

Fog.—A decided change in fog distribution occurred since the preceding month. Much less fog was observed in American coast waters, and much more was encountered over the ocean in east longitudes. Off the coast of California it was noted on 10 days and off the Peninsula of California and vicinity on 4 days. On the 27th the master of the S.S. *Chester Sun*, who observed fog south of Manzanillo, spoke of its occurrence there as extraordinary. Dense fog was met with near 10° N., 89° W., on the 19th. Fog was infrequent and scattered as a rule east of the 180th meridian, except along the coast, but was well distributed over the ocean in east longitudes, where April was the first month of its important occurrence since October 1933. Here it was observed on 1 to 2 or more days in most 5° areas north of the 30th parallel and on 3 days farther southward between the Ogasawara and Marianna Islands.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, April 1934

[For description of tables and charts, see REVIEW, January, p. 31]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	64.6	+0.8	3 stations	91	[1] 4	2 stations	30	13	3.68	−0.58	Milltown	6.96	Valley Head	1.45
Arizona	64.5	+3.6	do	104	[1] 20	do	11	3	.57	+.04	Flagstaff	3.01	12 stations	.00
Arkansas	62.7	+1.1	2 stations	90	[1] 2	Dutton	29	13	3.51	−1.39	Higden	8.18	Arkansas City	.57
California	60.3	+4.0	Greenland Ranch	107	[1] 11	South Lake	8	3	.52	−1.04	Redding	4.91	78 stations	.00
Colorado	48.0	+4.4	Las Animas	93	24	Hermit (near)	−8	4	.93	−.85	Buena Vista	3.03	Alamosa	.03
Florida	70.4	+.5	Chapman Field Garden.	93	21	Glen St. Mary	30	13	4.12	+1.30	Cottage Hill	8.95	2 stations	.91
Georgia	64.4	+.9	2 stations	94	[1] 4	Blairsville	24	13	3.99	+.41	Sparta	9.81	Glenville	.90
Idaho	52.6	+7.5	Orofino	96	22	Obsidian	−2	2	.82	−.53	Pierce	3.32	Indian Cove	.03
Illinois	53.3	+1.1	Harrisburg	89	4	Mount Carroll	19	25	1.81	−1.59	Chester	4.67	Streator	.64
Indiana	52.0	+.1	Shoals	93	4	2 stations	21	28	1.66	−1.85	Angola	3.23	Columbus	.67
Iowa	50.4	+1.7	2 stations	90	30	Webster City	12	25	1.07	−1.67	Keokuk No. 2	3.47	Oakland	.00
Kansas	57.1	+2.3	Garden City	96	30	Oberlin	21	13	1.27	−1.35	Arkansas City	5.37	2 stations	T
Kentucky	56.9	+.8	4 stations	90	[1] 4	Farmers	24	28	2.14	−1.81	Harlan	4.85	Grant	.73
Louisiana	68.0	+.9	Grand Coteau	92	18	2 stations	34	21	3.19	−1.43	New Orleans No. 2	6.62	Burrwood	1.29
Maryland-Delaware	51.9	−.5	Takoma, Md	86	2	Sines, Md	19	28	2.65	−.92	Maryland Line, Md.	4.12	Crisfield, Md	1.38
Michigan	40.8	−1.8	Houghton	85	30	Dukes	7	14	1.98	−.59	Deer Park	4.22	Kent City	.60
Minnesota	42.4	−.9	Maple Plain	96	30	Mizpah	13	27	1.12	−.93	Farmington	3.35	New London	.18
Mississippi	65.6	+1.0	Holly Springs	93	5	Shubuta	32	13	2.39	−2.43	Laurel	6.20	Grenada	.58
Missouri	56.5	+1.2	Jackson	90	4	Elsberry	24	25	2.41	−1.48	Lockwood	4.70	Tarkio	.65
Montana	48.0	+5.0	Outlook	88	28	Loweth	3	3	.49	−.66	Lytle	2.52	6 stations	T
Nebraska	52.1	+2.9	2 stations	95	[1] 29	2 stations	15	[1] 6	.54	−1.91	St. Paul	1.93	4 stations	T
Nevada	55.1	+7.3	Logandale	102	11	Zorra Vista Ranch	11	4	.43	−.32	Austin	3.12	7 stations	.00
New England	44.9	+1.1	Waterbury, Conn	80	18	Van Buren, Maine	5	5	4.62	+1.30	West Rockford, Maine.	7.49	Newport, N.H	1.92
New Jersey	49.4	−.3	Boonton	85	24	Layton	21	13	3.89	+.28	Little Falls	6.42	Tuckerton	1.74
New Mexico	54.8	+3.2	Artesia	104	10	Red River	−5	4	.49	−.41	St. Vrain	2.15	4 stations	.00
New York	44.7	+.4	Litchworth Park	83	30	Indian Lake	12	5	3.41	+.44	Hoffmeister	6.56	Rochester	1.36
North Carolina	59.1	+1.2	3 stations	92	4	Mount Mitchell	12	[1] 12	3.60	+.09	Elizabeth City	7.28	Lumberton	.47
North Dakota	43.7	+2.1	Steel	95	29	Cando	7	9	.44	−.95	2 stations	1.28	3 stations	.00
Ohio	49.5	−.3	Ironton	87	6	Millport	18	28	2.25	−.89	Fremont	5.79	Springfield No. 2	.53
Oklahoma	62.1	+1.7	Hollis	99	10	3 stations	29	[1] 1	2.64	−.79	Cheyenne	14.30	Boise City	.23
Oregon	53.8	+6.6	2 stations	95	22	Sand Creek	9	2	1.46	−.50	Sundown Ranch	5.20	Danner	.10
Pennsylvania	48.9	+.2	Ridgway	86	30	Kane	14	28	3.06	−.38	Hamburg	5.52	Lawrenceville	1.14
South Carolina	63.1	+.8	2 stations	92	[1] 3	Caesars Head	25	13	3.03	−.01	Blackville	7.60	Conway	.72
South Dakota	48.4	+2.3	White Lake	98	30	Camp Crook	11	15	.50	−1.63	Harveys Ranch	2.10	2 stations	.00
Tennessee	59.4	+.7	Dickson	95	4	6 stations	28	[1] 13	2.35	−2.07	Milan	5.81	do	.92
Texas	67.9	+1.7	2 stations	104	11	2 stations	32	[1] 7	3.14	−.02	Dialville	8.35	Clint	.01
Utah	53.3	+6.3	St. George	95	12	Soldier Summit	8	4	.42	−.75	Black's Fork (near)	1.81	Orr's Ranch	T
Virginia	55.1	+.5	3 stations	89	[1] 4	Hot Springs	21	28	2.76	−.52	Burkes Garden	5.54	Langley Field	1.09
Washington	55.0	+6.5	Wahluke	103	22	Paradise Inn	12	2	1.42	−.98	Camp Eight	5.92	Omak	.04
West Virginia	52.8	+1.0	Charleston	91	4	2 stations	18	28	2.58	−.95	Davis	4.93	Upper Tract	.80
Wisconsin	42.7	−1.1	2 stations	90	30	Long Lake	11	25	1.96	−.58	Holcombe	6.09	Big St. Germain Dam.	.31
Wyoming	44.7	+4.5	Pine Bluffs	86	30	Foxpark	−11	6	1.32	−.26	Dome Lake	4.88	Wamsutter	.06
Alaska (March)	17.1	+1.5	Tree Point	66	10	Allakaket	−51	6	1.77	−.02	View Cove	11.68	Barrow	.01
Hawaii	68.3	−1.8	Kaanapali	89	14	Kanalohuluhulu	39	16	9.62	+.60	Puohakamoa No. 2	52.00	2 stations	.00
Puerto Rico	75.0	+.3	Dorado	94	13	Guineo Reservoir	46	5	2.68	−2.01	Lares	9.72	Coamo	.20

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau Stations, April 1934*

[Compiled by Annie E. Small]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							**45.4**	**+1.5**										**74**	**3.64**	**+0.6**										**4.9**		
Eastport	76	67	85	29.94	30.03	+0.10	40.4	+1.4	56	18	47	23	5	34	24	37	35	84	2.61	−.2	10	8,582	sw.	44	e.	13	10	8	12	5.3	T	0.0
Greenville, Maine	1,070	6	40	28.82	30.00		39.4		73	30	49	16	5	30	45				5.61		13	4,723	se.	23		12	7	10	13		8.7	.0
Portland, Maine	103	82	117	29.89	30.01	+.05	44.6	+1.6	67	17	52	29	5	37	24	39	33	70	4.62	+1.2	12	7,306	s.	44	se.	12	15	8	7	3.8	.0	.0
Concord	289	60					45.9	+2.5	74	30	57	24	5	35					3.78		9		nw.				14	8	8			
Burlington	403	11	48	29.53	29.97	−.02	43.6	+.3	72	30	53	21	5	34	35				2.13	.0	14	7,891	s.	39	se.	11	8	7	15	6.3	T	.0
Northfield	876	12	60		30.00	+.01	41.8	+1.5	75	30	53	17	5	31	38			74	3.12	+.8	12	6,249	s.	34	se.	24	6	14	10	5.9	2.3	.0
Boston	124	336	360	29.87	30.01	+.04	48.0	+1.6	72	2	56	32	5	40	31	41	35	66	3.21	−.1	9	10,452	sw.	47	sw.	23	11	15	4	4.5	T	.0
Nantucket	12	14	90	30.00	30.01	+.04	44.8	+1.4	62	17	51	32	5	38	21	41	38	79	2.73	−.2	11	9,996	s.	36	ne.	1	14	6	10	4.9	.0	.0
Block Island	26	11	46	29.97	30.00	+.02	44.4	+.4	66	18	50	31	5	38	21	41	38	84	3.67	+.1	10	10,118	s.	37	nw.	27	12	8	10	4.9	.0	.0
Providence	160	215	251	29.83	30.01	+.03	49.0	+2.4	75	18	58	30	5	40	29	42	35	63	4.00	+.8	10	8,321	nw.	34	nw.	25	19	3	8	3.8	.0	.0
Hartford	159	70	104		30.00	+.01	49.0	+2.3	76	2	59	32	5	39	40				5.31	+2.0	14	6,164	s.				14	5	11		.0	.0
New Haven	106	74	153	29.90	30.02	+.03	48.4	+1.2	71	2	57	33	5	40	33	43	37	69	4.98	+1.5	12	6,611	s.	28	e.	12	12	8	10	4.9	.0	.0
Middle Atlantic States							**51.9**	**+0.3**										**68**	**2.62**	**−0.4**										**5.5**		
Albany	97	107	115	29.89	30.00	.00	47.5	+.7	75	24	57	27	5	38	33	41	34	65	2.82	+.4	12	6,026	s.	25	s.	24	10	8	12	5.5	.1	.0
Binghamton	871	60	68	29.04	29.98	−.04	45.5	+.1	74	10	56	26	22	35	40				2.29	−.2	12	4,728	nw.	19	sw.	24	8	4	18	6.9	2.2	.0
New York	314	415	454	29.66	30.00	.00	49.5	+.1	75	2	58	34	28	42	27	43	36	67	3.16	−.1	15	9,862	s.	44	nw.	24	11	8	11	5.1	T	.0
Bellefonte	1,050	5	42	28.85	29.97		46.3		73	10	59	22	28	34	41	41	35	69	3.04		12		w.	43	se.	11	8	10	12	5.8	.1	.0
Harrisburg	374	94	104	29.59	29.99	−.03	50.8	−.1	76	24	60	33	28	41	30	44	37	63	2.80	+.1	8	5,585	nw.	24	sw.	24	10	13	7	5.1	T	.0
Philadelphia	114	123	367	29.90	30.03	+.02	53.2	+1.1	79	2	62	35	28	44	30	45	38	64	3.11	+.1	10	8,520	s.	33	n.	20	12	9	9	4.7	.0	.0
Reading	323	283	306	29.64	30.00		50.8	+.5	78	24	61	31	13	41	33	44	37	63	2.56	−.7	12	8,640	nw.	41	se.	11	9	15	6	5.0	T	.0
Scranton	805	72	104	29.12	29.99	−.02	48.3	+.2	76	24	59	29	28	38	35	42	36	66	2.27	−.5	9	4,946	sw.	26	se.	11	9	9	12	5.6	T	.0
Atlantic City	52	37	172	29.96	30.02	+.02	48.9	+1.1	66	2	55	34	28	43	22	45	41	79	2.30	−.7	9	10,633	s.	45	se.	16	10	10	10	5.7	.0	.0
Sandy Hook	22	10	57	29.98	30.00		47.7		71	2	54	36	13	41	30	43	39	76	2.92	−.7	15	9,272	s.	35	s.	24	14	5	11	4.6	T	.0
Trenton	190	88	106	29.81	30.01		50.2	+.4	78	24	60	33	28	40	33	44	38	69	2.73	−.2	13	7,144	s.	29	w.	14	11	11	8	5.0	T	.0
Baltimore	123	100	215	29.87	30.00	−.01	53.8	+.2	83	2	63	35	28	45	34	47	40	63	2.32	−1.0	8	7,496	se.	32	nw.	24	11	9	10	5.3	T	.0
Washington	112	62	85	29.88	30.00	−.02	53.9	+.6	84	2	64	34	28	44	36	46	37	58	2.27	−1.0	10	5,126	s.	25	w.	24	11	8	11	5.4	T	.0
Cape Henry	18	8	54	29.99	30.01		55.0	+.4	84	27	63	38	13	47	39	49	44	75	2.59	−.7	10	8,964	se.	41	n.	28	8	13	9	5.6	.0	.0
Lynchburg	686	5		29.26	30.00	−.02	57.0	−.3	89	4	71	28	22	43	42				3.52	+.6	9		sw.				5	20	5		T	.0
Norfolk	91	170	205	29.92	30.02	+.01	57.6	+.8	82	2	68	36	13	48	34	50	44	70	2.04	−1.2	8	9,207	s.	41	nw.	11	6	11	13	6.4	.0	.0
Richmond	144	11	52	29.86	30.02	.00	56.8	+.2	84	2	68	32	13	45	40	49	44	69	2.10	−1.4	11	6,580	sw.	38	w.	24	7	12	11	5.9	.0	.0
Wytheville	2,304	49	55	27.61	29.98	−.05	51.2	−.8	79	3	62	27	12	41	36	44	38	66	2.71	−.3	12	5,425	w.	27	w.	11	7	13	10	5.7	1.1	.0
South Atlantic States							**62.9**	**+0.7**										**70**	**2.84**	**−0.1**										**5.0**		
Asheville	2,253	89	104	27.66	30.01	−.02	55.2	+1.3	82	3	67	29	13	44	41	47	41	67	2.89	−.1	11	6,010	nw.	27	nw.	11	9	9	12	5.8	.5	.0
Charlotte	779	244	267	29.18	30.01	−.02	59.8	.0	85	4	70	34	13	50	30	51	44	63	3.21	−.1	9	9,324	sw.	35	nw.	11	8	11	11	5.6	.0	.0
Greensboro	886	6	56	29.06	30.02		57.2		86	4	69	30	13	45	38	49	44	66	3.52		9	7,059	sw.	31	nw.	11	9	10	11	5.5	T	.0
Hatteras	11	5	50	30.00	30.00	−.01	58.8	−1.0	72	24	65	45	22	53	18	55	51	79	3.10	−.4	9	8,630	sw.	34	ne.	27	13	9	8	4.6	.0	.0
Raleigh	376	103	146	29.60	30.00	−.03	60.4	+1.0	88	3	72	35	13	49	36	52	45	64	3.09	−.4	10	6,972	sw.	27	nw.	11	7	12	11	5.8	.0	.0
Wilmington	72	73	107	29.94	30.01	−.02	63.4	+1.4	87	3	73	39	13	54	27	56	51	71	1.16	−1.5	7	7,736	sw.	31	w.	9	12	12	6	4.7	.0	.0
Charleston	48	11	92	29.98	30.02	−.01	65.8	+1.3	86	7	74	40	13	58	26	60	56	78	1.72	−.8	11	8,445	sw.	30	ne.	29	10	9	11	5.4	.0	.0
Columbia, S.C	351	41	57	29.64	30.02	−.01	63.9	+.6	88	4	74	35	13	54	32	55	50	69	2.81	−.1	12	6,137	sw.	24	w.	11	15	6	9	4.7	.0	.0
Augusta	182	62	77	29.81	30.00	−.03	64.6	+.4	89	3	75	39	13	54	35	55	48	63	5.74	+2.6	10	4,963	s.	24	nw.	11	13	9	8	4.8	.0	.0
Savannah	65	73	152	29.95	30.02	−.01	67.4	+1.4	87	7	78	40	13	57	29	59	54	74	1.73	−.8	8	8,510	sw.	31	nw.	12	17	7	6	4.0	.0	.0
Jacksonville	43	86	110	29.98	30.03	−.01	69.5	+.8	88	7	79	43	13	60	27	61	57	73	2.92	+.5	8	5,967	sw.	22	w.	11	14	9	7	4.4	.0	.0
Florida Peninsula							**74.4**	**+1.2**										**74**	**3.63**	**+1.5**										**4.0**		
Key West	22	10	64	29.98	30.00	−.02	77.0	+1.3	89	19	83	62	14	71	19	70	68	76	.93	−.4	9	6,947	e.	27	nw.	20	18	7	5	3.6	.0	.0
Miami	25	124	168	30.00	30.03	.00	74.0	+1.2	86	9	80	52	13	68	23	68	64	74	6.27	+3.2	12	7,302	ne.	31	s.	20	9	11	10	5.4	.0	.0
Tampa	35	88	197	29.99	30.03	−.03	72.1	+1.2	87	6	81	50	13	63	29	64	60	73	3.68	+1.7	7	7,583	e.	37	nw.	18	20	6	4	2.9	.0	.0
Titusville	43	5	36	29.98	30.03		69.2		88	17	80	43	14	58	32				5.80		9		se.			16	7	7			.0	.0
East Gulf States							**65.4**	**+0.8**										**71**	**3.27**	**−0.9**										**5.0**		
Atlanta	1,173	190	198	28.78	30.02	−.01	60.6	−.4	84	3	70	36	13	51	33	53	47	70	3.08	−.5	10	7,076	nw.	35	nw.	11	13	6	11	5.3	.0	.0
Macon	370	76	84	29.62	30.02	−.01	64.3	+.4	88	4	75	39	13	53	40	55	49	65	5.71	+2.6	11	5,362	s.	25	sw.	8	13	7	10	4.8	.0	.0
Thomasville	273	49	58	29.74	30.04	+.01	68.0	+1.3	90	5	80	39	13	56	32	59	55	74	1.78	−1.6	7		sw.				14	7	9		.0	.0
Apalachicola	35	11		29.99	30.03		67.0		80	27	75	44	13	59	23	62			3.22	+.4	7		sw.				14	13	3		.0	.0
Pensacola	56	149	185	29.97	30.03	+.01	66.6	−.1	81	11	73	48	21	60	20	61	58	80	2.76	−1.3	8	8,183	sw.	44	nw.	11	14	13	3	3.8	.0	.0
Anniston	741	9					63.4	+3.0	86	4	76	33	21	51	45				2.12	−2.2	11		nw.				8	11	11		.0	.0
Birmingham	700	11	48	29.25	30.01	−.01	63.1	−.2	88	4	74	38	13	53	31	54	48	65	2.83	−2.0	11	5,332	s.	22	n.	11	12	8	10	5.0	.0	.0
Mobile	57	125	161	29.96	30.02	.00	66.9	+.6	85	11	75	47	21	59	24	60	57	78	6.43	+1.8	10	6,847	s.	35	nw.	11	11	11	8	4.7	.0	.0
Montgomery	218	92	105	29.78	30.03	.00	65.6	+.3	88	4	76	39	13	56	33	57	51	67	3.40	−.9	8	5,241	sw.	22	n.	11	11	7	12	5.4	.0	.0
Meridian	375	67	92	29.62	30.01	−.01	65.0	+1.0	89	4	76	40	21	54	35	56	51	70	1.96	−2.8	8	4,847	sw.	22	sw.	22	11	11	8	4.9	.0	.0
Vicksburg	247	65	73	29.76	30.02	+.02	66.2	+.6	86	4	76	45	13	57	26	58	52	69	1.45	−3.7	10	5,540	s.	22	nw.	20	9	9	12	5.5	.0	.0
New Orleans	53	76	84	29.96	30.02	+.02	70.0	+1.2	84	11	77	54	1	62	25	62	58	73	4.55	−.7	10	4,841	sw.	25	sw.	10	9	10	11	5.4	.0	.0
West Gulf States							**67.8**	**+1.4**										**71**	**4.07**	**+0.5**										**5.0**		
Shreveport	249	92	227	29.73	30.00	+.03	68.0	+2.2	87	18	78	45	13	58	30	60	55	69	4.13	−.5	9	8,042	ne.	39	ne.	27	10	11	9	5.1	.0	.0
Bentonville	1,303	11	44	28.61	29.97	+.01	58.1	+1.2	83	10	68	36	13	48	32				2.07		7	5,255	n.	25	sw.	26	9	7	14		.0	.0
Fort Smith	457	79	94	29.50	29.98	+.02	63.2	+1.4	87	10	74	42	13	53	34	53	44	55	4.05	+.1	7	6,164	e.	32	sw.	4	14	8	8	4.2	.0	.0
Little Rock	357	94	102	29.63	30.00	+.02	62.4	+.3	86	26	72	40	13	53	33	53	44	58	5.81	+.6	9	6,380	s.	28	w.	5	10	10	10	5.3	.0	.0
Austin	605	136	148	29.33	29.96		70.1	+2.3	93	10	80	48	13	60	29	61	56	70	4.42	+.1	8	6,567	se.	32	se.	15	12	9	9	5.1	.0	.0
Brownsville	57	88	96	29.86	29.92		74.5	+.8	90	16	82	50	13	67	22	68	66	83	2.35	+.9	5	8,388	se.	29	se.	3	9	19	2	4.5	.0	.0
Corpus Christi	20	11	78	29.94	29.96	+.01	72.2	+1.4	92	10	78	60	14	67	23	67	65	82	3.74	+2.0	6	8,460	s.	32	e.	5	6	12	12	6.2	.0	.0
Dallas	512	220	227	29.42	29.97		66.4		89	23	75	48	21	58	29	59	54	70	3.55	−.7	8	9,065	se.	52	nw.	15	9	6	15	5.7	.0	.0
Fort Worth	670	106	114	29.26	29.97	+.03	67.2	+2.2	90	23	77	47	13	58	31				2.39	−1.6	8	6,887	s.	30	ne.	11	13	9	8	4.0	.0	.0
Galveston	54	106	114	29.94	30.00	+.03	69.5	+.8	78	27	74	59	13	65	15	64	62	83	5.67	+2.6	9	7,713	s.	32	sw.	11	10	13	7	4.9	.0	.0
Houston	138	292	314	29.85	30.00		70.4	+1.1	89	11	78	55	21	62	22				4.10	+.5	10	8,178	s.	49	nw.	19	8	12	10	5.4	.0	.0
Palestine	510	64	72	29.46	30.00	+.04	67.8	+1.8	86	10	78	48	13	58	27	60	55	72	4.82	+.4	9	6,180	s.	27	nw.	5	9	16	5	4.7	.0	.0
Port Arthur	34	58	66	29.96	30.00		69.8		83	18	76	53	13	63	18				3.32	+.3	9	6,157	s.	41	nw.	19	11	22	1	4.9	.0	.0
San Antonio	693	242	301	29.22	29.93	.00	70.8	+1.7	98	11	81	54	13	61	30	62	57	69	4.56	+1.4	13	8,855	se.	46	nw.	19	7	10	9	5.5	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, April 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							55.6	+0.6										61	2.04	−1.7										5.4		
Chattanooga	762	71	214	29.19	30.00	−0.03	61.6	+1.3	88	4	73	38	21	51	37	53	46	62	3.17	−1.7	11	6,081	w.	31	nw.	11	7	13	10	5.6	T	0.0
Knoxville	995	66	84	28.94	30.00	−.03	60.0	+2.0	87	4	71	35	13	49	35	50	43	60	2.38	−1.8	12	4,842	sw.	31	w.	11	11	10	9	4.9	T	.0
Memphis	399	78	86	29.58	30.00	.00	62.8	+1.0	83	5	72	44	13	54	27	54	48	62	1.27	−3.5	6	6,057	sw.	27	nw.	22	12	11	7	4.5	0.0	.0
Nashville	546	168	191	29.43	30.02	+.01	59.9	+.9	87	4	70	39	21	49	35	51	43	59	2.24	−1.9	8	7,178	nw.	38	nw.	11	9	8	13	5.7	T	.0
Lexington	989	5					55.4	+1.1	88	5	67	30	28	44	42				2.10	−1.4	14		ne.				13	9	8		T	.0
Louisville	525	188	234	29.42	30.00	−.01	56.4	.0	87	4	67	33	12	46	42	47	38	55	1.44	−2.4	7	7,780	s.	37	nw.	11	10	17	3	4.8	T	.0
Evansville	431	76	116	29.52	30.00	.00	57.4	+.7	86	4	67	38	28	48	35	48	39	55	1.99	−1.9	7	6,925	s.	32	sw.	1	9	10	11	5.5	.0	.0
Indianapolis	822	194	230	29.10	29.99	−.01	52.1	.0	79	3	62	32	13	42	42	44	36	59	2.23	−1.4	7	7,963	s.	34	w.	10	9	10	11	5.5	T	.0
Terre Haute	575	96	129	29.36	29.98		53.7		79	3	64	32	13	43	39	46	38	61	2.56	−1.1	8	7,050	s.	30	s.	1	12	9	9	4.9	T	.0
Cincinnati	627	11	51	29.30	29.99	−.02	53.5	+1.1	82	3	65	29	28	42	44	45	37	59	1.16	−2.0	7	5,859	sw.	27	sw.	1	8	10	12	5.7	.3	.0
Columbus	822	216	230	29.10	29.98	−.04	51.0	−.2	78	3	61	28	13	41	35	44	37	65	1.24	−1.6	12	8,109	s.	38	w.	11	8	12	10	5.6	.8	.0
Elkins	1,947	59	78	27.95	30.02	−.01	49.4	+.6	80	3	62	22	28	37	42	43	38	71	3.14	−.5	13	4,970	w.	38	w.	11	6	12	12	6.2	.8	.0
Parkersburg	637	77	84	29.36	30.02	−.01	53.4	.0	83	6	65	27	28	42	41	46	39	63	1.24	−2.0	9	5,181	nw.	27	w.	5	10	10	10	5.3	T	.0
Pittsburgh	842	353	410	29.07	29.99	−.03	50.4	−.8	79	3	61	29	28	40	37	43	37	68	2.41	−.5	12	7,571	w.	40	nw.	3	7	8	15	6.1	.4	.0
Lower Lake Region							45.0	−0.4										69	2.72	+0.2										6.3		
Buffalo	768	243	280	29.10	29.95	−.06	42.8	.0	68	10	51	25	28	34	37	37	33	77	1.96	−.6	17	10,732	sw.	43	w.	10	7	9	14	6.8	3.2	.0
Canton	448	10	61	29.45	29.94		42.1	−.4	74	10	51	21	5	33	42				3.19	+1.0	10	7,080	sw.	38	sw.	26	5	10	15	6.7	3.8	.0
Ithaca	836	77	100	29.05	29.97		45.4	+.4	75	30	56	26	22	35	37	40	34	68	2.62	+.1	15	7,265	nw.	39	se.	11	8	6	16	6.3	5.0	.0
Oswego	335	71	85	29.60	29.97	−.04	42.8	−.8	77	30	51	25	5	34	36	38	33	70	2.48	+.1	14	7,201	w.	28	se.	11	5	12	13	6.6	3.5	.0
Rochester	523	86	102	29.39	29.97	−.04	44.8	−.1	79	30	54	27	28	36	35	39	32	64	1.36	−1.0	17	5,063	w.	30	sw.	24	7	11	12	6.3	1.0	.0
Syracuse	596	65	79	29.32	29.97	−.04	46.0	+1.6	77	30	55	29	13	36	37				1.95	−.5	15	5,725	s.	22	se.	11	5	9	16	7.1	3.5	.0
Erie	714	130	166	29.18	29.96	−.06	45.0	−.1	77	30	54	27	13	36	29	40	35	73	2.10	−.6	16	9,178	w.	38	sw.	26	10	12	8	5.3	3.0	.0
Cleveland	762	267	337	29.13	29.96	−.06	47.3	+1.1	76	30	57	26	13	38	39	41	35	67	2.43	.0	16	9,495	w.	50	nw.	3	7	10	13	6.2	4.2	.0
Sandusky	629	5	67	29.28	29.97	−.05	46.4	−.8	76	30	56	26	13	37	32				4.09	+1.5	16	7,116	sw.	27	nw.	3	8	4	18	6.3	2.0	.0
Toledo	628	79	87	29.28	29.97	−.04	46.2	−1.4	74	30	55	25	13	37	30	40	35	69	5.31	+2.7	15	7,340	nw.	26	ne.	4	10	7	13	5.6	.7	.0
Fort Wayne	857	69	84	29.03	29.96		47.4	−1.9	77	3	57	28	12	38	34	41	35	66	2.37	−.7	11	7,212	nw.	30	nw.	23	11	5	14	6.2	.8	.0
Detroit	626	5	78	29.26	29.96	−.06	44.1	−2.1	73	30	53	24	13	35	35	38	33	70	2.79	+.3	12	7,928	nw.	41	nw.	3	6	7	17	6.6	1.3	.0
Upper Lake Region							40.7	−0.9										72	2.23	−0.3										6.9		
Alpena	609	13	89	29.23	29.91	−.11	38.0	−.6	81	29	46	19	13	30	43	33	29	74	2.10	−.1	15	8,973	nw.	30	sw.	30	3	12	15	7.2	5.1	.0
Escanaba	612	54	60	29.24	29.92	−.10	36.8	−1.1	63	8	44	18	14	30	33	32	27	74	3.01	+.8	9	8,038	s.	28	nw.	12	2	12	16	7.0	4.0	.0
Grand Rapids	707	70	244	29.16	29.94	−.08	44.2	−2.8	78	30	53	25	13	36	31	38	32	67	1.75	−1.0	12	9,247	sw.	38	sw.	23	8	8	14	6.3	1.1	.0
Lansing	878	6	88	28.98	29.94		43.0	−2.6	76	30	53	24	13	33	35	39	35	80	2.68	+.1	13	7,917	w.	30	nw.	3	7	7	16	6.6	4.6	.0
Ludington	637	5	54	29.22	29.92		41.2	−.7	68	30	47	25	13	35	29	36			1.30	−1.2	9		sw.				5	9	16		2.7	.0
Marquette	734	77	111	29.08	29.89	−.13	36.9	−.9	83	30	44	16	14	30	47	32	28	75	2.92	+.5	16	7,989	nw.	32	s.	8	1	12	17	8.0	21.2	.0
Sault Ste. Marie	614	11	52	29.20	29.91	−.12	34.0	−3.4	70	30	40	18	13	27	34	31	27	79	3.37	+1.2	17	6,876	nw.	25	nw.	26	5	10	15	6.8	5.6	.0
Chicago	673	7	131	29.22	29.96	−.04	48.6	+1.7	78	30	58	32	13	39	33	40	33	63	1.32	−1.5	13	8,313	sw.	28	nw.	12	8	7	15	6.0	T	.0
Green Bay	617	109	141	29.23	29.89	−.12	42.2	−1.0	76	30	50	27	1	34	37	36	30	67	1.91	−.7	13	9,103	nw.	36	s.	30	4	3	23	7.8	2.4	.0
Milwaukee	681	97	221	29.18	29.93	−.06	45.3	+1.5	80	30	54	31	13	37	37	38	31	65	1.53	−1.2	9	10,130	nw.	42	s.	3	8	8	14	6.3	.2	.0
Duluth	1,133	5	47	28.66	29.90	−.11	37.4	+.4	85	30	46	19	27	29	36	33	28	74	1.36	−.7	9	9,901	nw.	37	nw.	12	5	10	15	7.1	7.2	.0
North Dakota							43.6	+2.7										59	0.46	−1.1										4.8		
Moorhead, Minn.	940	50	58	28.92	29.95	−.04	42.4	+1.8	88	29	53	21	24	32	47	36	29	64	.66	−1.5	12	7,814	n.	35	n.	21	5	9	16	6.6	4.9	.0
Bismarck	1,674	8	57	28.18	29.98	+.01	45.4	+3.3	86	28	58	19	24	33	48	37	26	55	.32	−1.2	4	8,294	nw.	36	nw.	21	17	8	5	4.0	2.1	.0
Devils Lake	1,478	11	44	28.38	29.98	−.01	41.0	+2.2	83	29	52	18	24	30	42	34	27	64	.58	−.9	8	8,592	nw.	35	n.	21	6	13	11	5.9	2.3	.0
Grand Forks	833	12	67				41.3		90	29	52	19	27	31	51	36			.91		8		nw.	41	nw.	21	6	17	7		8.2	.0
Williston	1,878	41	48	28.01	30.01	+.05	45.6	+3.6	83	28	58	22	16	33	42	36	25	52	.30	−.9	1	7,681	nw.	31	w.	22	24	3	3	2.5	3.0	.0
Upper Mississippi Valley							51.3	+1.0										58	1.39	−1.6										5.1		
Minneapolis	918	102	208	28.92	29.91	−.08	46.0	−.4	91	30	56	27	27	36	40	38	27	53	1.57	−.7	7	9,434	nw.	35	nw.	12	9	4	17	6.8	.4	.0
La Crosse	714	11	48	29.13	29.91	−.07	47.1	−.1	85	30	57	25	25	37	42	39	32	62	.90	−1.5	9	5,370	nw.	24	nw.	12	9	6	15	6.1	.1	.0
Madison	974	70	78	28.86	29.92	−.07	45.8	+.4	76	30	54	30	25	37	36	39	30	60	1.08	−1.7	8	7,790	nw.	30	nw.	12	10	6	14	5.7	.1	.0
Charles City	1,015	10	51	28.85	29.94	−.04	47.0	+.6	84	30	59	23	21	35	43	39	30	57	.96	−1.6	7	6,731	nw.	26	sw.	18	15	6	9	4.5	T	.0
Davenport	606	66	161	29.30	29.96	−.02	51.3	+1.4	78	30	62	30	25	41	36	43	34	58	1.06	−1.6	6	8,144	sw.	31	nw.	12	10	9	11	5.1	T	.0
Des Moines	861	5	99	29.05	29.96	−.01	51.8	+1.7	81	30	64	28	25	40	36	42	32	54	.98	−1.9	7	8,580	nw.	30	nw.	11	13	7	10	4.6	.0	.0
Dubuque	700	60	79	29.18	29.93	−.05	49.6	+1.0	81	30	60	29	25	40	38	41	31	54	1.03	−1.8	6	5,802	nw.	24	nw.	23	11	5	14	5.7	.4	.0
Keokuk	614	64	78	29.31	29.98	.00	54.1	+1.8	80	9	64	31	21	44	34	45	36	55	2.64	−.4	7	6,846	nw.	26	nw.	12	13	5	12	4.7	.0	.0
Cairo	358	87	93	29.61	29.99	.00	59.4	+1.3	85	4	69	39	12	50	35	50	41	56	1.69	−2.0	9	7,086	n.	32	nw.	11	10	8	12	5.4	.0	.0
Peoria	609	11	45	29.31	29.98	−.01	51.6	+.7	79	3	63	28	25	40	37	44	36	61	1.13	−2.2	8	6,135	nw.	24	w.	12	15	8	7	3.9	T	.0
Springfield, Ill	636	5	191	29.28	29.96	−.02	54.6	+1.9	77	18	65	34	21	44	31	46	38	59	1.21	−2.3	6	9,242	s.	35	nw.	11	14	4	12	4.8	.0	.0
St. Louis	568	265	303	29.37	29.98	.00	57.0	+1.2	82	4	67	36	12	47	29	49	42	61	2.40	−1.4	8	9,003	s.	35	nw.	10	16	7	7	4.0	.0	.0
Missouri Valley							54.7	+2.9										49	1.45	−1.5										3.9		
Columbia, Mo.	784	6	84	29.15	29.99	+.01	56.3	+1.4	82	10	67	32	25	45	35				1.28	−2.5	6	6,901	nw.	32	nw.	11	17	10	3	3.2	.0	.0
Kansas City	750	32	45	29.17	29.98	+.02	57.7	+2.9	86	10	69	36	21	46	40	47	38	54	2.40	−.7	6	8,266	nw.	40	nw.	11	12	9	9	4.5	.0	.0
St. Joseph	967	11	49	28.94	29.98		56.8		85	10	68	34	21	45	38	45	34	49	3.36	+.3	5	7,254	nw.	33	nw.	11	18	6	6	3.6	.0	.0
Springfield, Mo.	1,324	98	104	28.59	29.99	+.02	56.8	+.8	81	10	66	37	13	48	27	48	40	60	3.77	−.1	10	7,352	s.	29	nw.	11	16	7	7	3.9	.0	.0
Iola	984	11	50	28.94	29.98	+.03	58.6	+2.4	87	10	72	34	28	45	37				2.10	−1.4	9		n.				17	6	7		.0	.0
Topeka	987	65	87				57.6	+2.9	89	10	70	36	20	46	38				1.49	−1.3	7	7,609	s.	32	nw.	11	18	3	9	3.5	.0	.0
Lincoln	1,189	11	81	28.70	29.97	+.03	55.2	+3.7	87	29	68	29	25	42	44	44	32	48	.35	−2.2	4	8,677	s.	38	nw.	11	14	9	7	4.1	.0	.0
Omaha	1,105	170	200	28.80	29.98	+.03	55.0	+3.8	85	29	67	31	13	43	38	43	30	45	.28	−2.2	6	9,699	n.	39	nw.	11	16	9	5	4.1	.0	.0
Valentine	2,598	47	54	27.28	30.01	+.07	49.6	+3.9	90	30	63	24	13	36	46	39	27	48	.36	−1.5	2	7,574	n.	31	n.	11	14	10	6	4.2	.3	.0
Sioux City	1,138	64	106	28.74	29.96	+.01	51.9	+4.1	86	30	64	29	13	40	45	42	20	48	.55	−2.2	3	8,507	nw.	37	nw.	11	14	8	8	4.5	.0	.0
Huron	1,306	60	74	28.57	29.98	+.02	48.4	+3.3	91	29	61	23	24	36	43	38	24	45	.03	−2.2	2	8,113	n.	30	nw.	11	19	4	7	3.6	T	.0
Northern Slope							48.6	+5.4										53	1.24	−0.3										4.3		
Billings	3,140	4					51.6		84	22	70	23	12	34	50				.41		2		nw.				12	11	7		.0	.0
Havre	2,505	11	67	27.38	30.02	+.09	49.6	+5.9	81	27	65	20	16	34	49	38	27	51	.83	−.2	3	7,072	e.	34	nw.	8	20	5	5	3.1	1.8	.0
Helena	4,124	85	111	25.81	29.99	+.02	50.0	+6.5	77	20	62	22	3	38	38	40	30	50	.56	−.6	4	6,364	sw.	38	sw.	1	13	7	10	4.8	4.4	.0
Kalispell	2,973	48	56	26.94	29.99	+.03	51.4	+7.8	79	22	64	26	3	39	37	42	33	58	.68	−.1	5	5,064	nw.	22	ne.	13	17	7	6	3.6	2.6	.0
Miles City	2,371	48	55	27.49	30.06	+.10	50.0	+5.3	81	29	64	22	16	36	42	38	25	44	.40	−.7	2	5,616	s.	30	n.	13	15	11	4	3.7	.3	.0
Rapid City	3,259	50	58	26.61	30.04	+.09	48.4	+4.1	83	29	61	19	5	36	41	39	27	48	1.17	−.9	5	6,845	n.	28	n.	21	16	11	3	3.7	8.8	.0
Cheyenne	6,094	50	71	24.01	30.00	+.09	44.5	+3.6	75	30	56	18	4	32	40	35	27	57	1.54	−.4	8	7,109	n.	30	w.	10	10	11	9	5.4	15.5	.0
Lander	5,372	60	68	24.65	30.02	+.08	46.4	+4.0	75	22	59	17	6	34	38	38	29	60	3.10	+1.0	10	4,273	sw.	38	sw.	1	9	15	6	4.9	23.8	.0
Sheridan	3,790	10	47	26.11	30.03		47.5		82	30	62	20	6	32	45	38	27	56	2.39	+.5	6	4,273	nw.	24	nw.	13	14	10	6	4.4	18.5	.0
Yellowstone Park	6,241	11	48	23.90	30.02	+.06	44.6	+7.6	70	22	59	11	2	30	40	35	26	59	1.14	−.3	5	5,919	sw.	30	sw.	30	9	13	8	5.4	2.2	.0
North Platte	2,821	11	51	27.05	29.98	+.06	52.3	+3.7	88	29	66	27	13	38	50	41	29	50	.62	−1.4	6	6,337	n.	32	n.	11	16	5	9	4.3	T	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, April 1934*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air									Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation			Wind					Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with 0.01 or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Slope							56.4	+3.0										51	1.23	-1.1										4.5		
Denver	5,292	106	113	24.73	29.98	+0.08	51.4	+4.3	79	25	64	19	4	39	39	40	27	49	1.10	-1.0	9	5,996	s.	33	n.	2	9	14	7	5.0	8.8	0.0
Pueblo	4,685	80	86	25.28	29.95	+.07	53.8	+3.7	85	25	69	27	4	39	47	41	26	44	.60	-.7	6	5,138	nw.	25	s.	2	10	16	4	4.9	1.7	.0
Concordia	1,392	50	58	28.54	30.02	+.09	57.1	+3.6	88	10	70	33	13	45	41	45	34	50	.71	-1.6	6	7,380	n.	32	nw.	11	15	10	5	3.7	.0	.0
Dodge City	2,509	10	86	27.40	29.99	+.09	56.2	+2.6	89	30	69	35	5	43	43	44	32	49	.42	-1.5	5	9,008	s.	38	s.	2	16	6	8	4.1	.0	.0
Wichita	1,358	85	93	28.55	29.98	+.05	57.8	+1.4	85	10	68	37	20	48	29	48	38	53	3.10	+.2	8	8,038	n.	30	sw.	30	13	6	11	4.6	.0	.0
Oklahoma City	1,214	10	47	28.70	29.97	+.05	61.9	+2.1	91	10	73	40	28	51	33	52	44	59	1.46	-1.8	6	7,566	s.	29	n.	11	10	9	11	4.9	.0	.0
Southern Slope							65.4	+2.6										53	1.17	-.6										4.5		
Abilene	1,738	10	52	28.15	29.95	+.05	66.0	+1.6	92	10	78	41	28	54	36	55	48	61	2.61	-.1	11	7,469	s.	38	s.	17	14	8	8	4.6	.0	.0
Amarillo	3,676	10	49	26.25	29.94	+.07	60.8	+5.0	89	10	74	37	4	48	38	46	33	44	.77	-1.1	7	7,332	ne.	28	sw.	2	14	12	4	4.1	.0	.0
Big Spring	2,537	5	62	27.34	29.94	-----	65.2	-----	92	10	78	39	28	53	37	54	46	60	1.85	-----	6	-----	s.	-----	-----	-----	13	11	6	4.2	.0	.0
Del Rio	944	64	71	28.90	29.88	-.01	72.6	+2.0	100	11	83	53	14	62	39	61	53	59	1.17	-.6	5	7,061	se.	41	w.	18	10	11	9	5.6	.0	.0
Roswell	3,566	75	85	26.33	29.90	+.05	62.4	+1.8	88	23	77	35	5	48	38	47	32	41	.14	-.8	2	6,802	s.	38	nw.	15	14	11	5	4.0	.0	.0
Southern Plateau							63.5	+6.2										41	.12	-.2										2.9		
El Paso	3,778	152	175	26.14	29.86	+.03	68.0	+4.6	91	24	80	44	4	56	29	49	31	30	.05	-.2	2	7,476	w.	41	sw.	25	22	6	2	2.1	.0	.0
Albuquerque	4,972	5	39	25.02	29.86	-----	56.7	-----	83	24	73	19	4	41	45	43	31	45	.13	-----	2	7,167	n.	43	nw.	15	9	17	4	4.8	.0	.0
Santa Fe	7,013	38	53	23.24	29.89	+.05	51.1	+4.4	73	23	64	21	4	38	35	39	27	47	.46	-.5	7	4,667	sw.	22	sw.	2	10	17	3	4.8	3.2	.0
Flagstaff	6,907	10	59	23.34	29.88	+.04	47.2	+5.0	74	11	63	17	4	31	44	37	-----	57	3.01	-----	7	6,408	nw.	30	sw.	2	8	19	3	-----	1.0	.0
Phoenix	1,108	10	107	28.69	29.83	-.04	74.8	+7.8	99	21	90	43	4	60	40	53	33	28	.07	-.3	1	4,502	e.	24	sw.	3	24	4	2	2.0	.0	.0
Yuma	141	9	54	29.68	29.82	-.07	76.0	+6.5	101	21	93	44	4	59	43	58	42	37	.00	-.1	0	3,944	sw.	22	n.	3	26	4	0	.8	.0	.0
Independence	3,957	5	26	25.94	29.93	+.03	63.9	+8.8	88	12	81	35	3	47	41	45	-----	-----	.00	-.1	0	-----	nw.	-----	-----	-----	25	3	2	-----	.0	.0
Middle Plateau							55.7	+7.3										37	0.68	-0.3										3.6		
Reno	4,527	61	76	25.48	29.96	-.01	55.0	+7.7	81	19	71	26	3	39	42	42	29	43	.95	+.5	1	5,263	w.	31	w.	1	20	8	2	2.5	T	.0
Tonopah	6,090	12	20	-----	-----	-----	56.5	-----	76	11	68	21	3	45	30	41	23	29	T	-----	0	-----	w.	-----	-----	-----	-----	-----	-----	-----	-----	-----
Winnemucca	4,344	18	56	25.61	29.98	+.02	54.2	+7.5	86	20	72	24	4	37	47	41	26	42	.95	+.1	7	5,630	ne.	25	w.	1	15	12	3	3.3	3.3	.0
Modena	5,473	10	46	24.58	29.88	.00	52.2	+6.2	80	11	70	20	3	34	46	38	19	34	.51	-.4	4	7,535	sw.	36	sw.	16	12	13	5	4.3	.6	.0
Salt Lake City	4,360	86	210	25.58	29.91	-.01	58.0	+8.4	84	23	70	29	2	46	31	44	29	39	.46	-1.6	4	5,622	nw.	27	nw.	1	14	10	6	4.0	3.0	.0
Grand Junction	4,602	60	68	25.32	29.87	-.01	59.0	+6.6	84	29	73	30	4	45	36	43	26	36	.55	-.3	3	5,083	se.	25	sw.	30	15	10	5	4.0	2.5	.0
Northern Plateau							57.0	+7.8										51	0.56	-0.6										4.2		
Baker	3,471	48	53	26.46	30.04	+.04	52.3	+7.1	84	22	67	26	2	38	43	44	36	60	1.34	+.2	8	5,022	sw.	26	sw.	12	12	12	6	4.3	4.0	.0
Boise	2,739	79	87	27.14	29.99	+.01	57.6	+7.2	90	22	71	29	3	44	37	46	34	48	.46	-.7	5	4,301	nw.	21	sw.	1	15	10	5	4.2	.5	.0
Pocatello	4,477	60	68	25.44	29.93	-.01	54.4	+8.4	83	21	68	30	2	41	41	42	28	44	.28	-1.2	7	6,002	se.	26	sw.	4	13	8	9	4.3	.1	.0
Spokane	1,929	101	110	27.96	30.00	+.01	56.5	+8.1	84	21	69	32	15	44	39	46	36	53	.34	-.8	5	4,713	s.	24	nw.	1	16	7	7	3.9	T	.0
Walla Walla	991	57	65	28.93	30.00	-.01	60.4	+7.3	91	22	72	36	2	49	37	50	41	52	.44	-1.1	5	3,967	s.	20	w.	28	16	8	6	4.0	T	.0
Yakima	1,076	58	67	28.87	30.01	-----	61.0	+8.5	91	22	74	36	3	48	37	49	37	47	.47	.0	4	4,278	nw.	19	nw.	4	12	11	7	4.7	.0	.0
North Pacific Coast Region							55.5	+6.3										74	1.96	-1.1										5.8		
North Head	211	11	56	29.86	30.09	+.04	52.2	+4.7	68	18	56	40	1	48	17	49	47	88	2.03	-2.1	14	8,516	n.	39	s.	28	7	8	15	6.7	.0	.0
Seattle	125	90	321	29.92	30.05	+.02	56.4	+7.0	81	20	65	37	1	48	32	50	44	68	1.37	-1.0	11	5,319	n.	34	sw.	22	6	11	13	6.1	.0	.0
Tatoosh Island	86	10	54	29.98	30.08	+.08	50.3	+4.2	65	18	54	40	1	46	16	48	46	88	2.80	-2.8	11	7,531	sw.	43	e.	18	4	7	19	7.3	.0	.0
Medford	1,329	29	58	28.61	30.01	-----	57.8	-----	88	20	74	30	3	42	46	49	41	62	1.11	-.1	6	4,044	nw.	22	w.	1	13	7	10	4.7	.0	.0
Portland, Oreg.	153	68	106	29.89	30.04	-.02	59.8	+8.0	90	20	70	39	3	50	35	53	47	66	2.46	-.4	10	4,114	nw.	21	sw.	22	11	6	13	5.8	.0	.0
Roseburg	510	45	76	29.50	30.05	-.02	58.7	+7.7	91	20	73	33	3	44	44	51	46	70	2.00	-.3	7	2,955	n.	20	sw.	23	14	7	9	4.4	.0	.0
Middle Pacific Coast Region							60.8	+5.4										71	0.97	-1.1										3.9		
Eureka	62	73	89	30.02	30.09	-.02	53.6	+3.7	64	23	58	42	3	49	20	52	50	92	1.68	-1.6	12	5,099	n.	27	n.	2	5	11	14	6.3	.0	.0
Red Bluff	330	5	58	29.61	29.96	-.07	66.4	+7.4	92	19	81	43	3	52	40	55	47	57	1.54	-.2	4	4,326	nw.	21	se.	30	17	5	8	3.6	.0	.0
Sacramento	66	87	115	29.90	29.97	-.04	64.4	+6.3	89	7	79	43	9	50	37	54	47	61	.16	-1.4	2	5,289	s.	26	nw.	2	23	4	3	1.9	.0	.0
San Francisco	155	208	243	29.84	30.01	-.04	59.0	+4.0	77	6	66	48	8	52	27	52	48	75	.51	-1.1	4	5,548	w.	27	w.	14	15	9	6	3.9	.0	.0
South Pacific Coast Region							64.8	+5.5										64	0.00	-0.9										3.3		
Fresno	327	97	105	29.60	29.95	-.04	67.6	+7.4	92	20	83	38	3	52	39	54	41	46	T	-1.0	0	5,298	nw.	24	sw.	22	24	5	1	1.7	.0	.0
Los Angeles	338	159	191	29.60	29.96	-.03	64.6	+5.2	86	26	73	52	4	56	28	56	51	69	T	-1.0	0	3,986	sw.	16	w.	3	16	9	5	3.6	.0	.0
San Diego	87	62	70	29.86	29.95	-.04	62.3	+3.8	74	28	68	52	4	57	20	57	54	78	.01	-.8	1	4,971	w.	20	s.	14	13	9	8	4.6	.0	.0
West Indies																																
San Juan, P.R.	82	9	54	29.93	30.02	-----	77.0	+.4	89	12	83	68	6	71	18	-----	-----	-----	1.25	-3.1	8	8,463	e.	30	e.	23	9	19	2	4.8	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	-----	[1] 29.83	.00	82.1	+.5	93	3	90	71	1	74	21	-----	-----	[1] 78	5.09	+2.0	7	5,547	nw.	24	nw	25	1	21	8	6.3	.0	.0
Cristobal	36	6	97	-----	[1] 29.86	.00	82.4	+.6	88	16	86	74	17	78	13	76	75	[1] 79	5.48	+1.3	17	8,651	n.	24	n.	1	4	17	9	6.1	.0	.0
Alaska																																
Fairbanks	454	11	7	[2] 29.23	[2] 29.76	-----	33.1	-----	58	25	44	5	12	22	40	29	20	59	.57	+.3	7	4,607	ne.	23	sw.	15	5	7	18	7.2	4.9	.0
Juneau	80	96	116	[2] 29.90	[2] 29.99	-----	42.4	-----	63	23	49	31	13	36	25	39	35	76	6.55	-----	20	5,131	s.	27	se.	4	3	5	22	8.0	6.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 30.01	[2] 30.05	-----	70.6	-2.4	80	26	75	61	9	66	14	65	62	75	.81	-1.3	8	7,873	ne.	29	e.	19	9	13	8	5.5	.0	.0

[1] Observations taken bihourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service*

APRIL 1934

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Mean maximum	Temperature: Mean minimum	Temperature: Highest	Temperature: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	In.	In.	In.	°F.	°F.	°F.	°F.	°F.	°F.	In.	In.	In.
Cape Race, Newfoundland	99				34.8		39.3	30.4	45	11	2.47		0.0
Sydney, Cape Breton Island	48	30.01	30.06	+0.17	37.9	+2.9	46.1	29.8	62	14	5.28	+1.43	4.0
Halifax, Nova Scotia	88	29.76	29.87	-.09	40.9	+3.1	48.2	33.7	64	25	6.01	+1.83	.0
Yarmouth, Nova Scotia	65	29.90	29.97	+.01	42.1	+3.2	49.6	34.6	61	26	3.36	-.46	.0
Charlottetown, Prince Edward Island	38	29.95	29.99	+.09	39.6	+4.4	47.0	32.2	62	24	2.48	-.17	2.8
Chatham, New Brunswick	28	29.89	29.92	+.02	38.6	+3.1	47.0	30.1	64	17	4.56	+1.93	3.8
Father Point, Quebec	20	29.93	29.95	+.02	36.7	+3.5	43.4	30.1	62	14	3.54	+1.96	.0
Quebec, Quebec	296	29.65	29.98	-.01	38.9	+3.8	45.1	32.8	70	15	3.56	+1.47	1.8
Doucet, Quebec	1,236				32.2		41.1	23.3	71	0	3.81		23.2
Montreal, Quebec	187												
Ottawa, Ontario	236	29.67	29.94	-.08	40.3	+.3	48.4	32.3	74	20	3.80	+2.39	7.8
Kingston, Ontario	285	29.63	29.95	-.07	40.5	+.5	47.4	33.6	63	26	2.35	+.56	4.2
Toronto, Ontario	379	29.53	29.95	-.07	42.0	+1.2	50.0	34.1	71	27	2.61	+.24	1.9
Cochrane, Ontario	930				30.6		38.2	23.1	71	4	2.54		12.9
White River, Ontario	1,244	28.52	29.86	-.18	28.1	-4.9	37.7	18.5	61	-4	3.47	+2.22	30.6
London, Ontario	808				40.4		49.0	31.8	70	18	3.42		5.4
Southampton, Ontario	656	29.19	29.92	-.11	38.2	-.5	46.4	30.1	74	20	1.42	-.38	4.0
Parry Sound, Ontario	688	29.20	29.90	-.12	37.3	-.3	45.4	29.3	74	19	2.55	+.64	14.5
Port Arthur, Ontario	644	29.16	29.88	-.15	34.5	+1.0	41.6	27.3	61	19	1.04	-.68	7.9
Winnipeg, Manitoba	760	29.10	29.94	-.08	37.9	+2.0	46.2	29.7	85	17	.88	-.17	2.4
Minnedosa, Manitoba	1,690	28.13	29.98	-.03	37.3	+1.3	47.7	27.0	76	16	.57	-.49	3.6
Le Pas, Manitoba	860				33.1		43.9	22.4	64	-2	1.67		10.5
Qu'Appelle, Saskatchewan	2,115	27.67	29.93	-.06	40.8	+3.4	53.4	28.3	82	12	.53	-.52	2.2
Moose Jaw, Saskatchewan	1,759				43.2		57.7	28.6	86	12	.09		.1
Swift Current, Saskatchewan	2,392	27.41	29.95	-.01	44.8	+3.5	59.4	30.2	84	14	.11	-.82	.5
Medicine Hat, Alberta	2,365	27.44	29.93	+.01	48.5	+4.0	62.2	34.7	83	18	.24	-.50	.0
Calgary, Alberta	3,540	26.29	29.97	+.07	46.3	+6.7	59.3	33.3	81	19	.62	-.02	.6
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.42	30.01	+.03	40.1	+4.0	51.6	28.6	80	8	1.04	+.21	6.3
Battleford, Saskatchewan	1,592	28.23	29.99	+.02	42.0	+4.8	54.9	29.1	83	13	.95	+.48	2.9
Edmonton, Alberta	2,150	27.68	29.98	+.09	45.4	+5.5	56.8	33.9	80	19	1.46	+.58	3.0
Kamloops, British Columbia	1,262	28.72	30.00	+.07	56.3	+7.4	71.1	41.6	90	30	.13	-.26	.0
Victoria, British Columbia	230	29.80	30.06	+.05	50.2	+3.4	60.4	40.1	75	36	1.06	-1.31	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				49.0		53.7	44.4	60	34	5.05		.0
Prince Rupert, British Columbia	170				45.2		53.4	36.9	65	31	5.53		.0
Hamilton, Bermuda	151	29.91	30.07	+.02	68.3	+4.4	72.5	64.0	77	58	9.11	+4.93	.0

LATE REPORTS FOR MARCH 1934

Stations	Altitude	Station pressure	Sea level pressure	Departure	Mean	Departure	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure	Total snowfall
Cape Race, Newfoundland	99				27.0		32.8	21.3	38	6	4.11		2.1
Hamilton, Bermuda	151	30.06	30.22	+0.14	65.9	+3.7	71.1	60.8	77	55	3.67	-1.46	.0

SEVERE LOCAL STORMS, APRIL 1934

(Compiled by Mary O. Souder)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Stanford (near), Mont.	2			1		Blizzard	Man died from cold, exposure, and fatigue in the Big Belt Mountains.	Official, U.S. Weather Bureau.
St. Croix, Dunn, Eau Claire, Chippewa, Barrow, and 6 other counties, Wis.	2-3			9	$1,000,000	Floods	Damage to highways and bridges	Do.
Milwaukee, Wis.	3	8:20 a.m.			10,000	Thundersquall	3 large roofs blown off; windows blown in; garage and barn overturned; streets flooded and many cars stalled; 1 person injured by lightning and several by objects blown by the wind.	Do.
Minnesota, southeastern counties bordering the Mississippi River.	3	A.m.		3		Excessive rain	Small streams overflowed their banks, inundating farm lands and highways; railroad tracks washed out in a number of places, one washout causing wreck of freight train 1 mile east of Hudson, Wis., in which 3 men were killed; some livestock perished; much property damage.	Do.
Fowlerville (near), Mich.	3	1:30 p.m.		1		Wind, electrical	Several barns blown down, another burned by lightning; man killed by falling timber when his barn was completely demolished.	Do.
Leedey, Okla., and vicinity	3	5:30-9 p.m.			12,500	Heavy hail	Some livestock killed; many windows broken and considerable property damaged; loss to crops; path few miles wide and about 15 miles long.	Do.
Fairview, Okla., 12 miles southwest.	3	6 p.m.	200		5,000	Tornado	2 persons injured; crops not sufficiently advanced to be damaged; loss to property; path 5 miles long.	Do.
Cheyenne, Okla., 8 miles west	3	6-11 p.m.	[1] 10		12,000	Heavy hail	Loss to crops $10,000; property loss $2,000	Do.
Anthony, Kans., 8 miles northeast.	3	9 p.m.	33		1,000	Wind	Barn and several buildings wrecked; storm had tornadic characteristics.	Do.
Cleveland, Ohio	3	P.m.			40,000	2 thundersqualls and hail.	Electric light poles blown down; cables disabled by lightning and wind; roofs blown off; windows smashed; walls blown down; trees uprooted; several automobiles and trucks blown over.	Do.
Eaton County, Mich.	3			1		Electrical	Man killed when his barn was struck by lightning.	Do.

[1] Miles instead of yards.

SEVERE LOCAL STORMS, APRIL 1934—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Michigan, southeastern portion	3					Wind	Considerable damage to telephone lines and to trees.	Official U. S. Weather Bureau.
Chautauqua Lake, N.Y., Ashville Bay to Beechwood.	3					do	Severe wind piled thousands of tons of ice along south shore causing damage to boats, boathouses and docks amounting to several thousand dollars.	Do.
Spencerville, Ohio	3				500	Hail	Hailstones as large as hen's eggs; damage chiefly to greenhouses and to automobile tops.	Do.
Upper Washita Valley, Okla	3-4			17	580,000	Excessive rain and flood.	Destruction to property and loss to crops	Do.
Vimville, Miss	4	5 p.m			500	Wind	House completely demolished, an occupant being slightly injured; on a nearby farm outbuildings were damaged and some chickens killed.	Do.
Western Colorado	4					Snow	A 2-foot blanket of new snow covered the Red Mountain Pass route between Ouray and Silverton; busses operating on the route could not get through; Monarch Pass also closed.	Do.
Woodward and Blaine Counties, Okla.	4				7,600	Rain and flood	The North Canadian River in extreme southeastern Woodward and western Blaine Counties rose rapidly and overflowed some bottom lands in this vicinity.	Do.
Brookshire, Tex	5	2:15 a.m	100			Tornado	4 buildings completely demolished and several damaged; 1 person injured; path 440 yards long.	Do.
Oil Trough, Ark	5-6	P.m			1,000	Wind	House demolished and several damaged	Do.
Erick, Okla., 1 mile southeast	6	8-9 p.m	[1] 2		500	Heavy hail	Damage principally to crops; path 3 miles long	Do.
Helena (near), Mont	8	P.m		3		Wind	3 men drowned in Hauser Lake when their outboard motor craft foundered and sunk from strong winds and high waves.	Do.
Winchester and Springdale, Kans.	9	5 p.m	100			Tornado	Funnel-shaped cloud seen at Kansas City, 30 miles distant; no buildings struck; damage small.	Do.
Independence (near), La	10	1 p.m				Heavy hail	Considerable damage to strawberry crop, amount not estimated.	Do.
Picayune, Miss	10				2,000	Wind	Barn destroyed	Do.
West Palm Beach, Fla	11	2:30 p.m				Tornadic wind	Minor damage to plate-glass windows and awnings for distance of 2 blocks; 2 persons cut by flying glass.	Do.
Springfield, Mo	11	6 p.m				Dust and wind	Dust storm here worst in city's history; wind reported to have reached a velocity of 125 miles an hour at a height of 10,000 feet.	Do.
Norfolk, Va	11	6:37-7:50 p.m.				Thunder and electrical.	Electric service in many section of the city disrupted.	Do.
Norfolk and Nansemond Counties, Va.	11	7-7:30 p.m.	[1] 2		11,000	Hail	Windows broken; automobile tops punctured and bark of young trees damaged; $10,000 loss to crops; path 20 miles long.	Do.
Mendenhall, Miss., vicinity of	12				5,000	do	Considerable damage to vegetable crops; windows broken.	Do.
Mohawk Valley, central portion, and the Adirondacks, N.Y.	12					Snow	6 to 18 inches of snow fell resulting in hazardous traffic for automobiles.	Do.
Venice, La	15	5:30 p.m	880		5,000	Thundersquall	4 persons injured, 2 severely; property damaged	Do.
Johnston (near), S.C	17	4 p.m	800		15,000	Heavy hail	Damage to peach and asparagus crops; path 6 miles long.	Do.
Arkadelphia, Ark., and vicinity.	17	6 p.m	440			do	Severe damage to fruit and gardens; path 5 miles long.	Do.
Kerrville (near), Tex	17	6:30 p.m	5			Hail	Severe damage to crops; considerable damage to roofs and windows; path 20 miles long; no estimate of damage given.	Do.
Jefferson Davis, Parish, La	17	11 p.m	2,640			do	Considerable damage to gardens and crops; path several miles long.	Do.
Arkadelphia, Ark., 6 miles south.	18				5,000	Wind and hail	Several barns blown down; cotton gin unroofed	Do.
High Island, Tex	19	6:20 a.m	[1] 2		42,000	Tornadic winds	$40,000 damage to oil derricks; other damage to garages, fences, etc.	Do.
Jefferson Davis, Acadia, Vermilion, Lafayette, and St. Landry Parishes, La.	19	9-10 a.m		4		Gales, electrical	Great damage to dwellings, barns, warehouses, and trees; a number of oil derricks blown down.	Do.
Opa Locka, Fla	19	4 p.m	32		1,625	Tornadic wind and hail.	Moderate hail caused $1,000 damage to crops; wind blew in 30-ton door of dirigible hangar causing damage of $625.	Do.
Kosciusko, Miss	22					Hail	Considerable damage to growing crops	Do.
Shellmound, Miss., vicinity of	22				7,000	do	Damage to buildings $2,000 and an estimated loss of $5,000 to growing crops.	Do.
Davenport, Iowa	23	1:30 – 2:30 p.m.				Severe dust storm	This storm was widespread and visibility at its height was reduced to ⅕ of a mile; the penetrating dust caused much discomfort.	Do.
Frenchville Gorge, N.Y., 10 miles north of Rome.	24	10:30 a.m	35			Severe wind	1 person injured; several buildings unroofed; large barn demolished; many trees uprooted; length of path 1½ miles; damage amounting to several thousand dollars.	Do.
Richmond, Va	24	4-5 p.m	[1] 1		1,100	Thundersquall	About 200 telephones put out of order; property damage.	Do.
Syracuse, Kans., vicinity of	26	1 p.m	[1] 1		500	Heavy hail	Chief damage to fruit and truck; path 1 mile long	Do.
Weiser, Idaho, 3 miles east	29	3 p.m	[1] 1		3,000	Hail	Damage to gardens, fruit, trees, and crops	Do.
Bell-Mikesville, Fla	29	3:30-4 p.m.	[1] 2		35,000	Heavy hail	Loss to crops estimated at $20,000; $15,000 damage to timber and houses; path 25 miles long.	Do.
Idaho County, Idaho, western portion.	29	9 p.m	[1] 10		10,000	Hail	Loss to crops; path 15 miles long	Do.
New London, Minn., vicinity of.	29	do				Wind	Small farm building damaged	Do.
Jefferson County, Mont., southeastern portion.	30	3 p.m	[1] 2		1,000	Tornadic winds	Ground badly blown; damage to light buildings; path 5 miles long.	Do.
Nekoma, Kans	30	7 p.m	440		1,500	Tornado	1 person injured; bank building, lumber yard, and smaller buildings damaged.	Do.
Hutchinson, Minn., vicinity of	30	5:30 p.m			10,000	Thundersquall and hail.	Property damaged; a personal injury was reported due to a school bus being turned over by the wind.	Do.
Dighton, Kans	30	7:30 p.m	50		500	Tornado and dust	2 persons slightly injured; small house demolished; path 440 yards long.	Do. Do.
Ness County, Kans., northeastern portion.	30					Heavy rain	3.25 inches of rain fell washing out ¼ mile of Missouri Pacific track at Brownell and damaging the track at Warring and McCracken.	Do.

[1] Miles instead of yards.

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Chart I. Departure (°F.) of the Mean Temperature from the Normal, April 1934

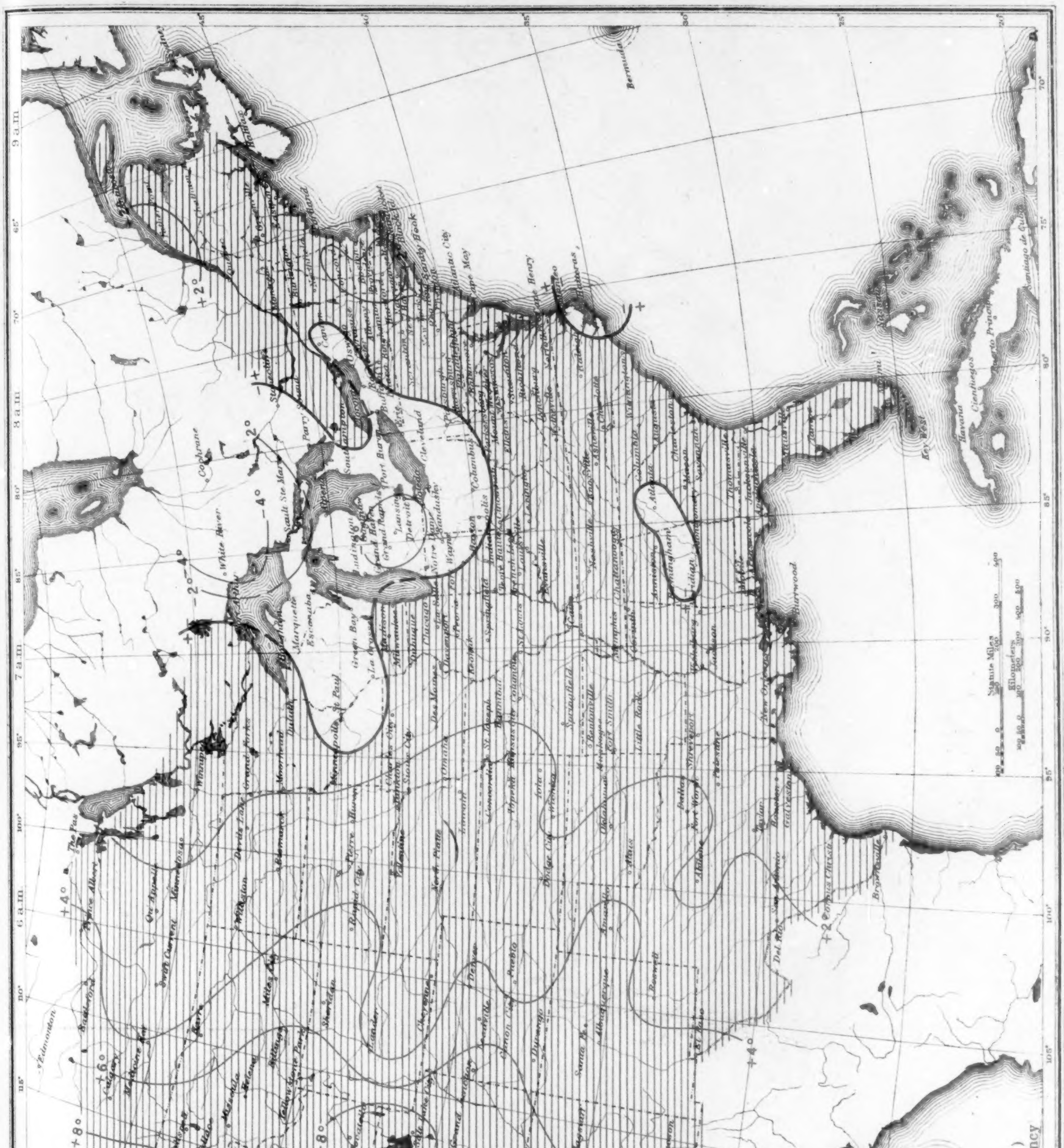
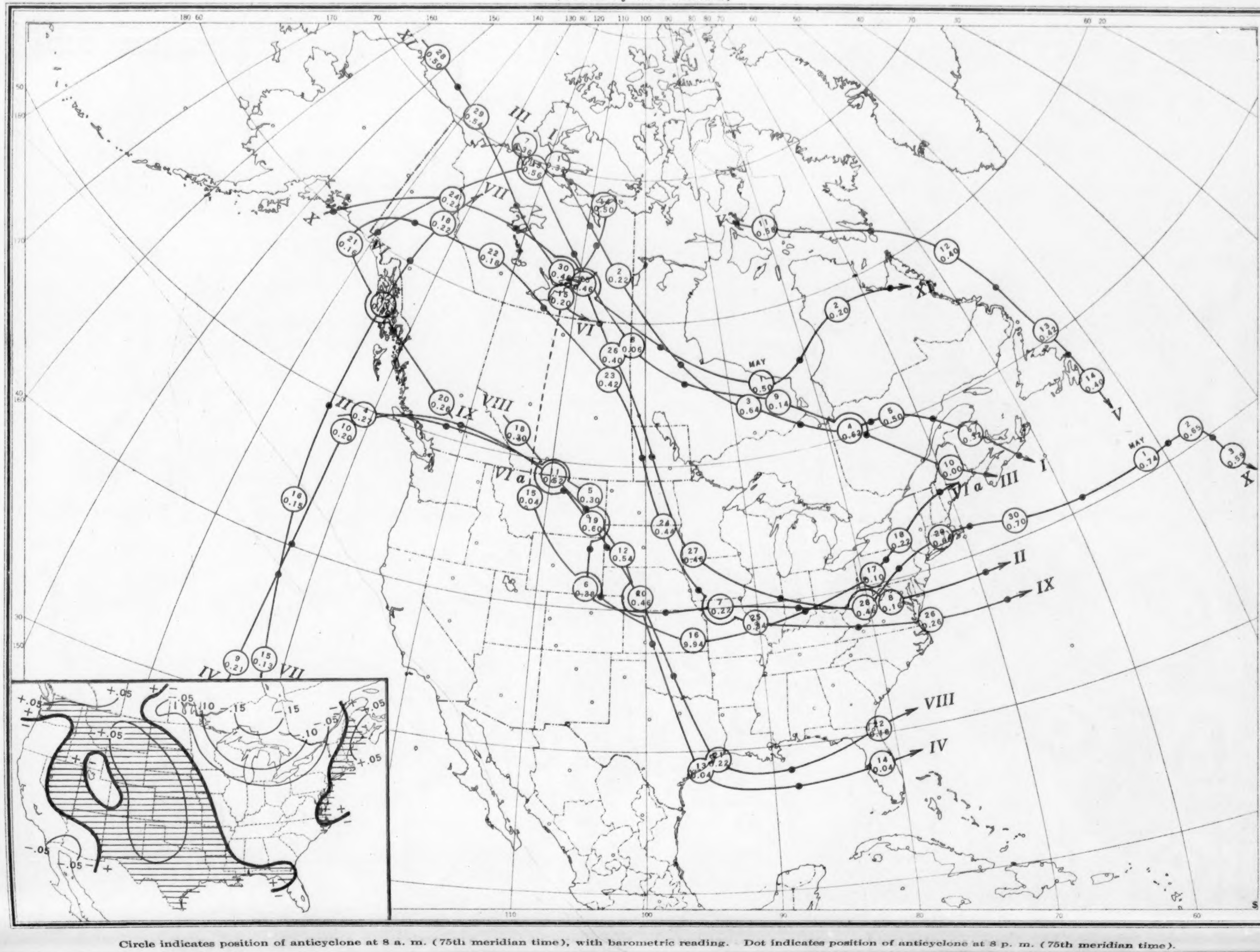


Chart I. Departure (°F.) of the Mean Temperature from the Normal, April 1934

Chart II. Tracks of Centers of Anticyclones, April 1934. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. R. Stevens)

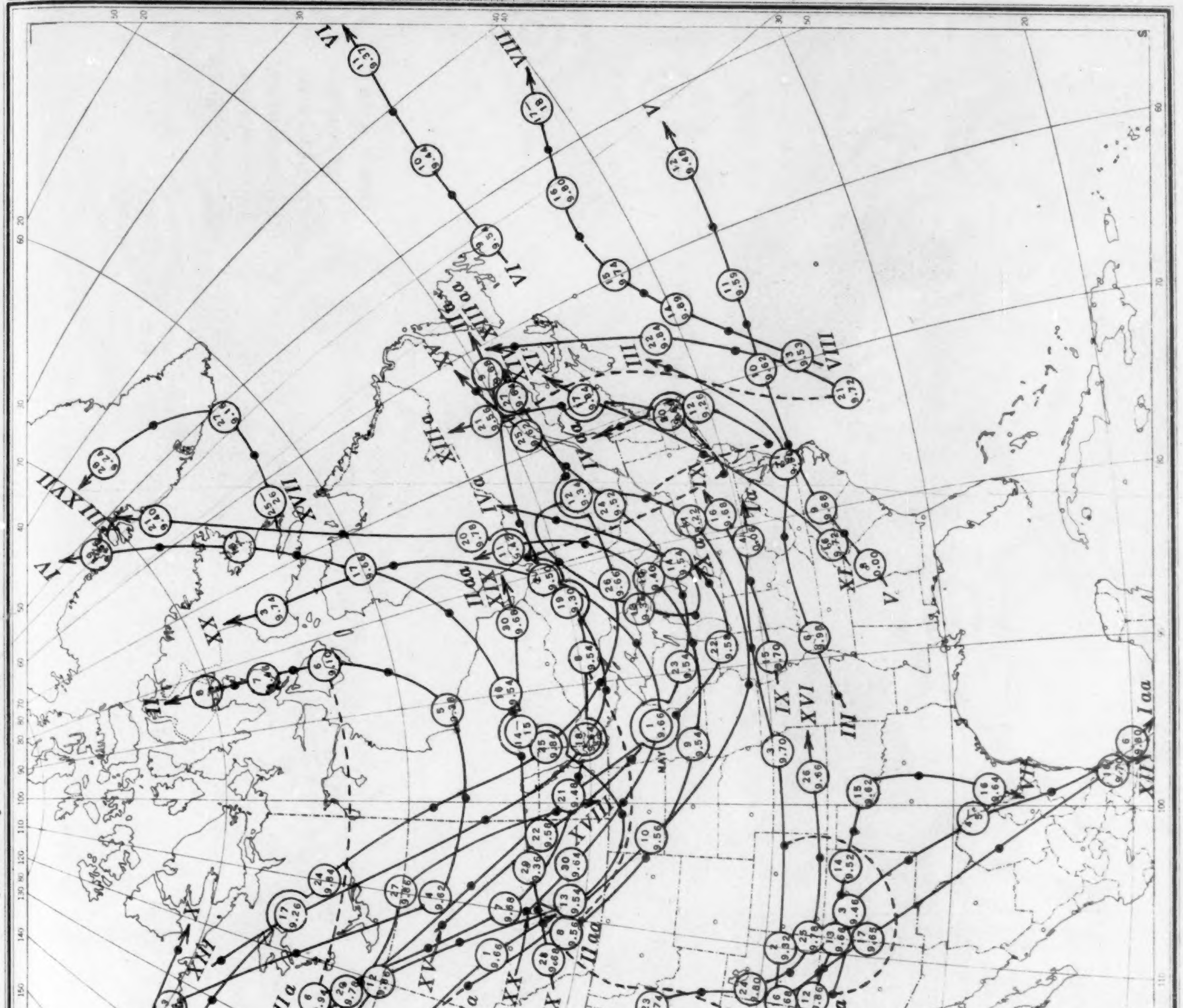


Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, April 1934. (Inset) Change in Mean Pressure from Preceding Month

Chart III. Tracks of Centers of Cyclones, April 1934. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. R. Stevens)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, April 1934

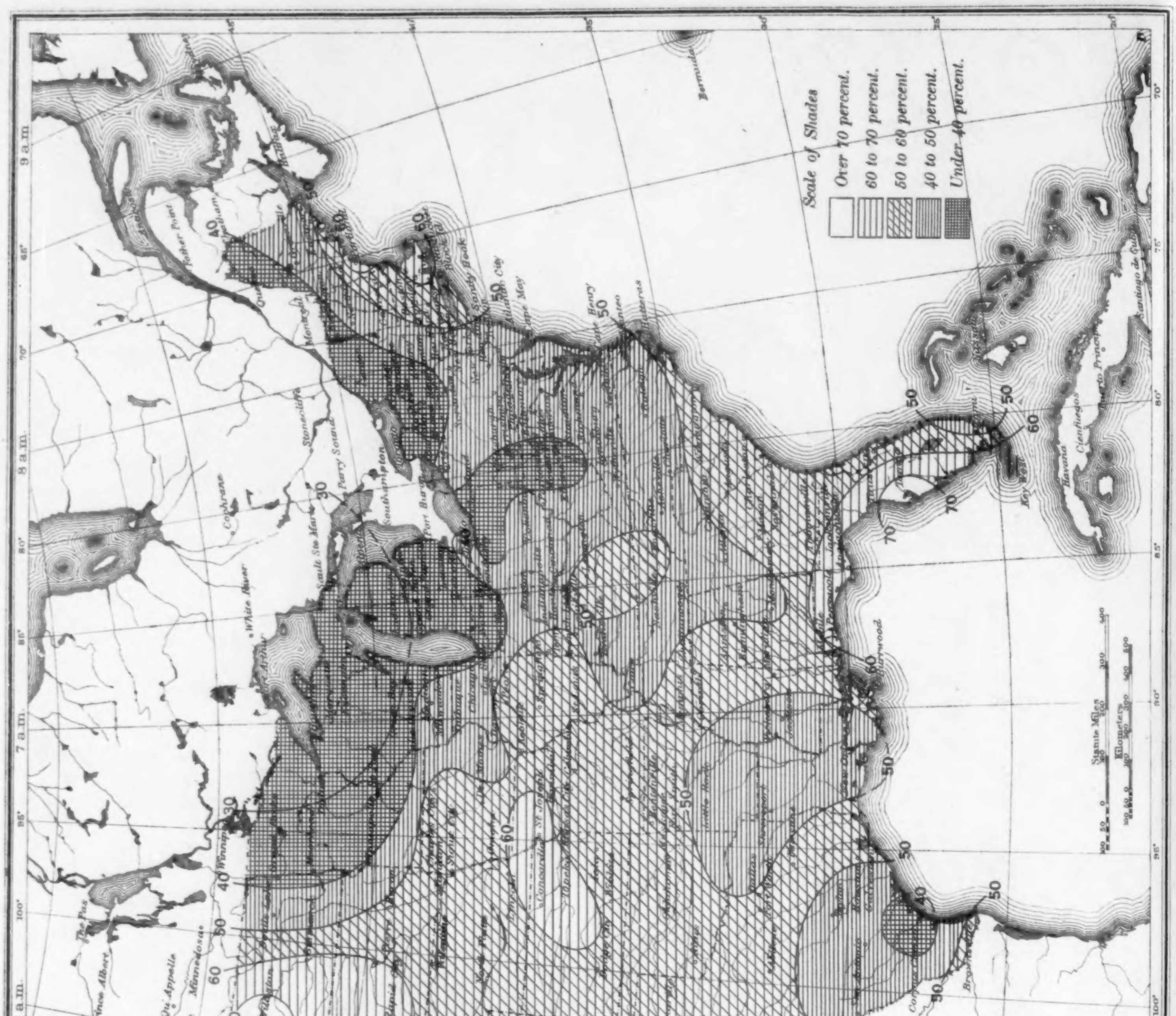


Chart V. Total Precipitation, Inches, April 1934. (Inset) Departure of Precipitation from Normal

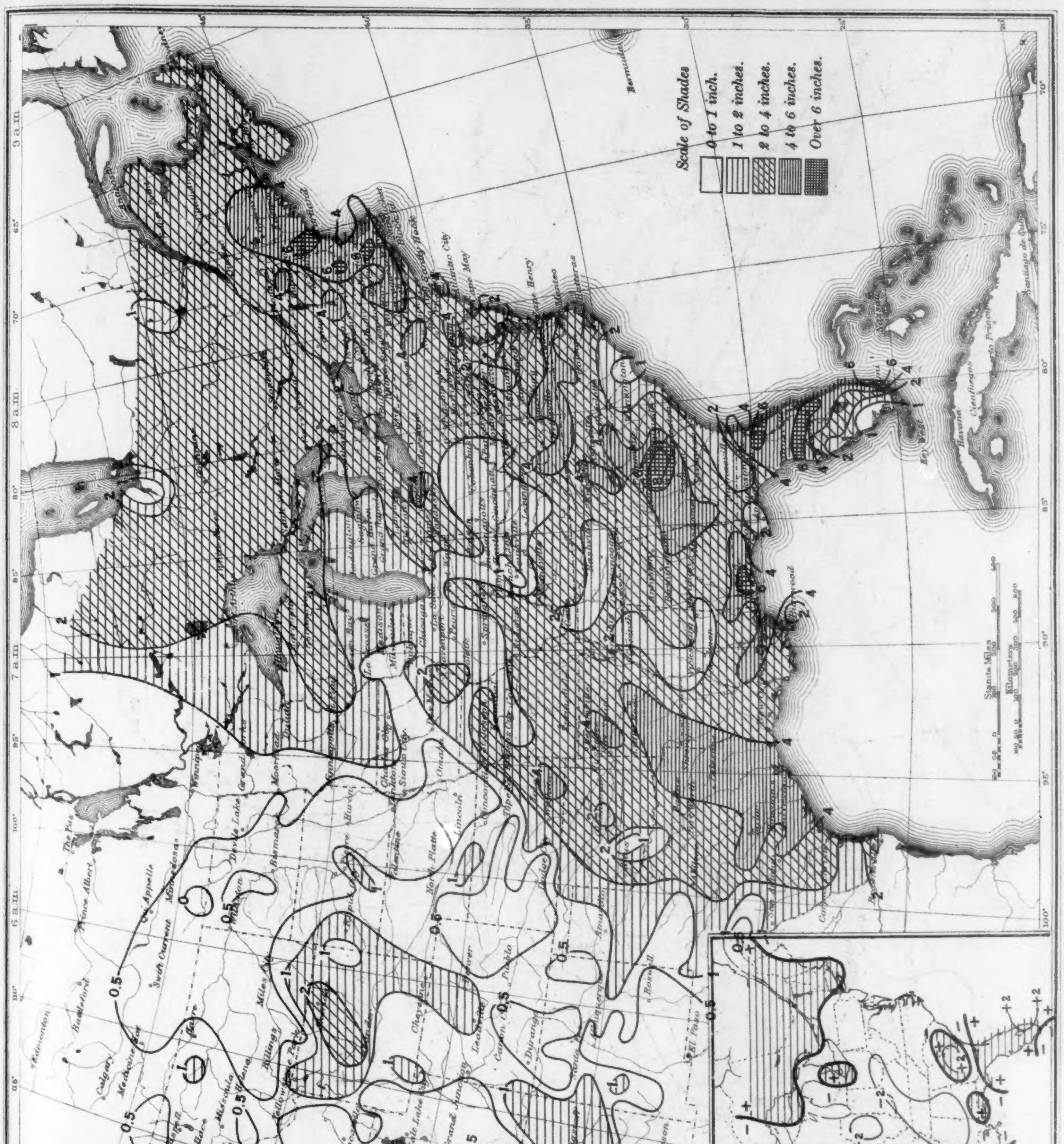


Chart V. Total Precipitation, Inches, April 1934. (Inset) Departure of Precipitation from Normal

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, April 1934

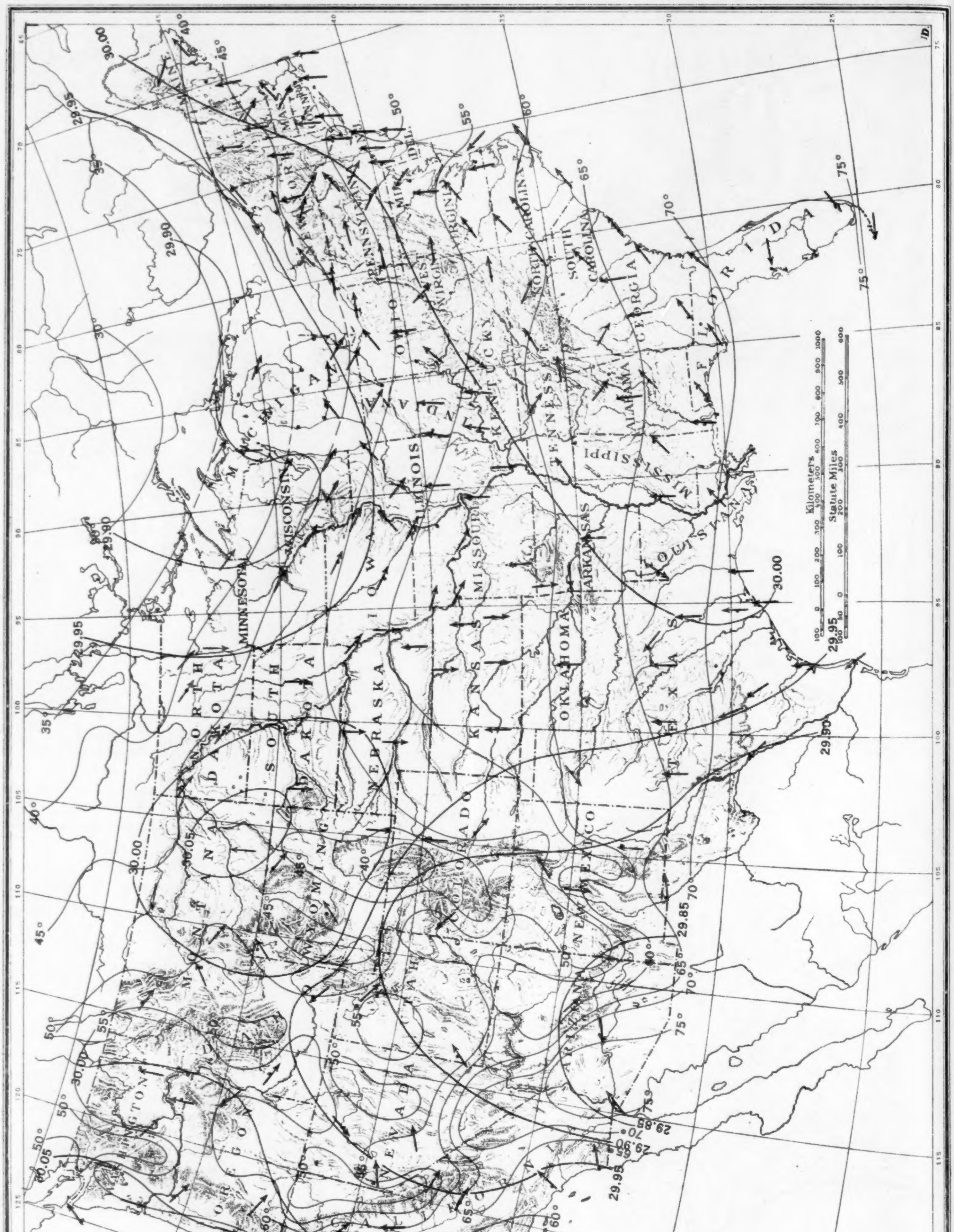


Chart VII. Total Snowfall, Inches, April 1934.

Chart VII. Total Snowfall, Inches, April 1934.

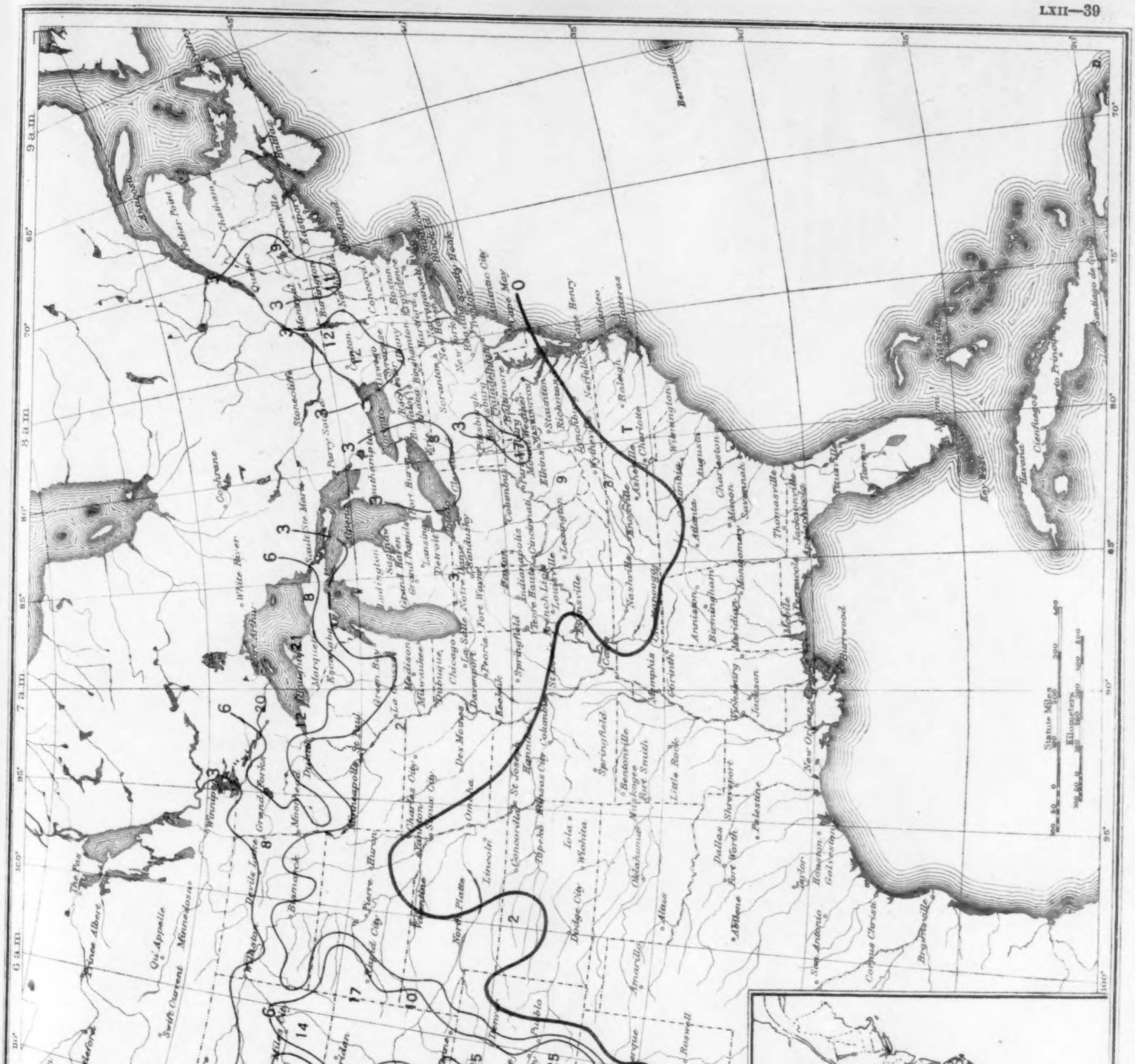
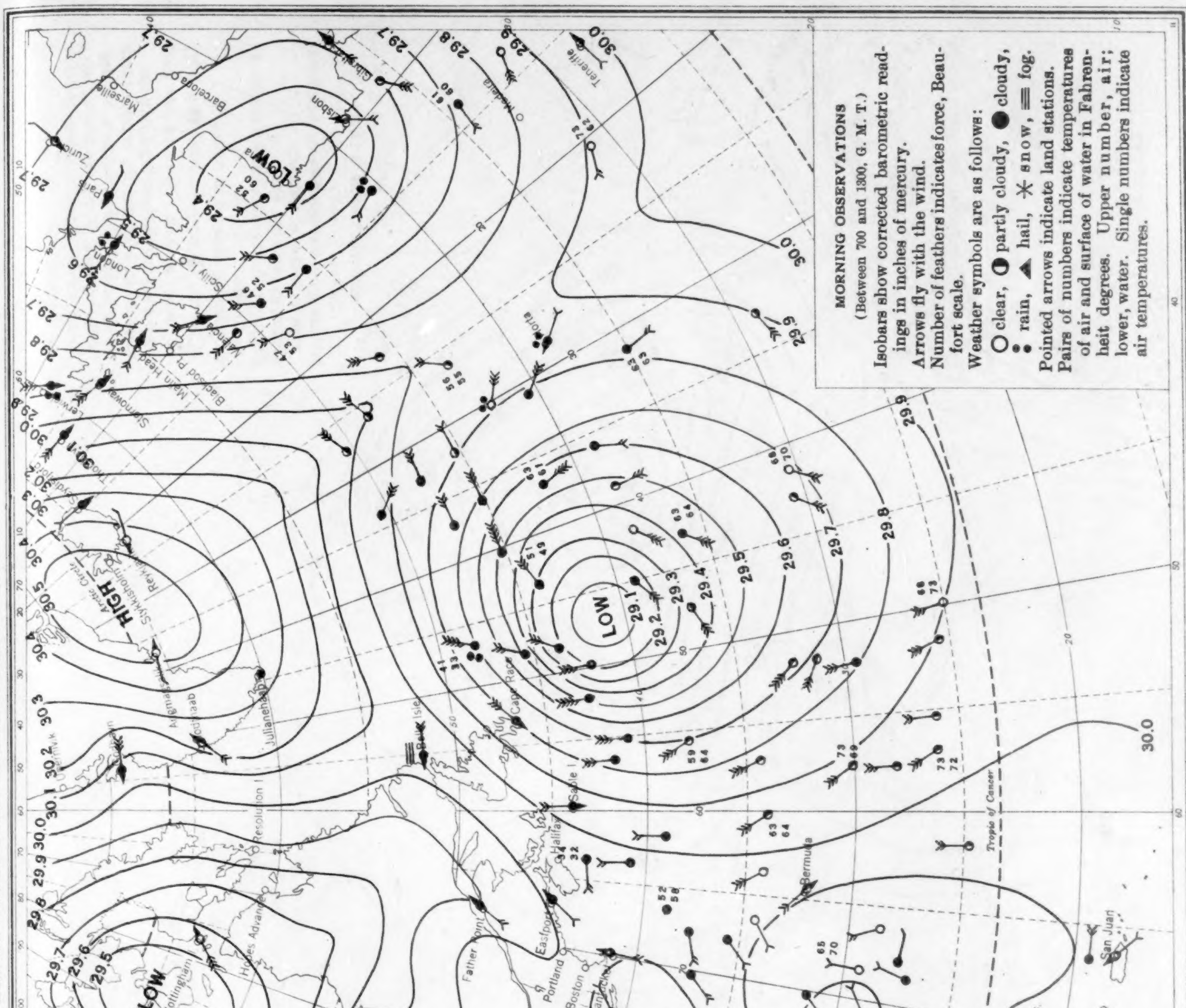


Chart VIII. Weather Map of North Atlantic Ocean, April 7, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)



(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart IX. Weather Map of North Atlantic Ocean, April 8, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

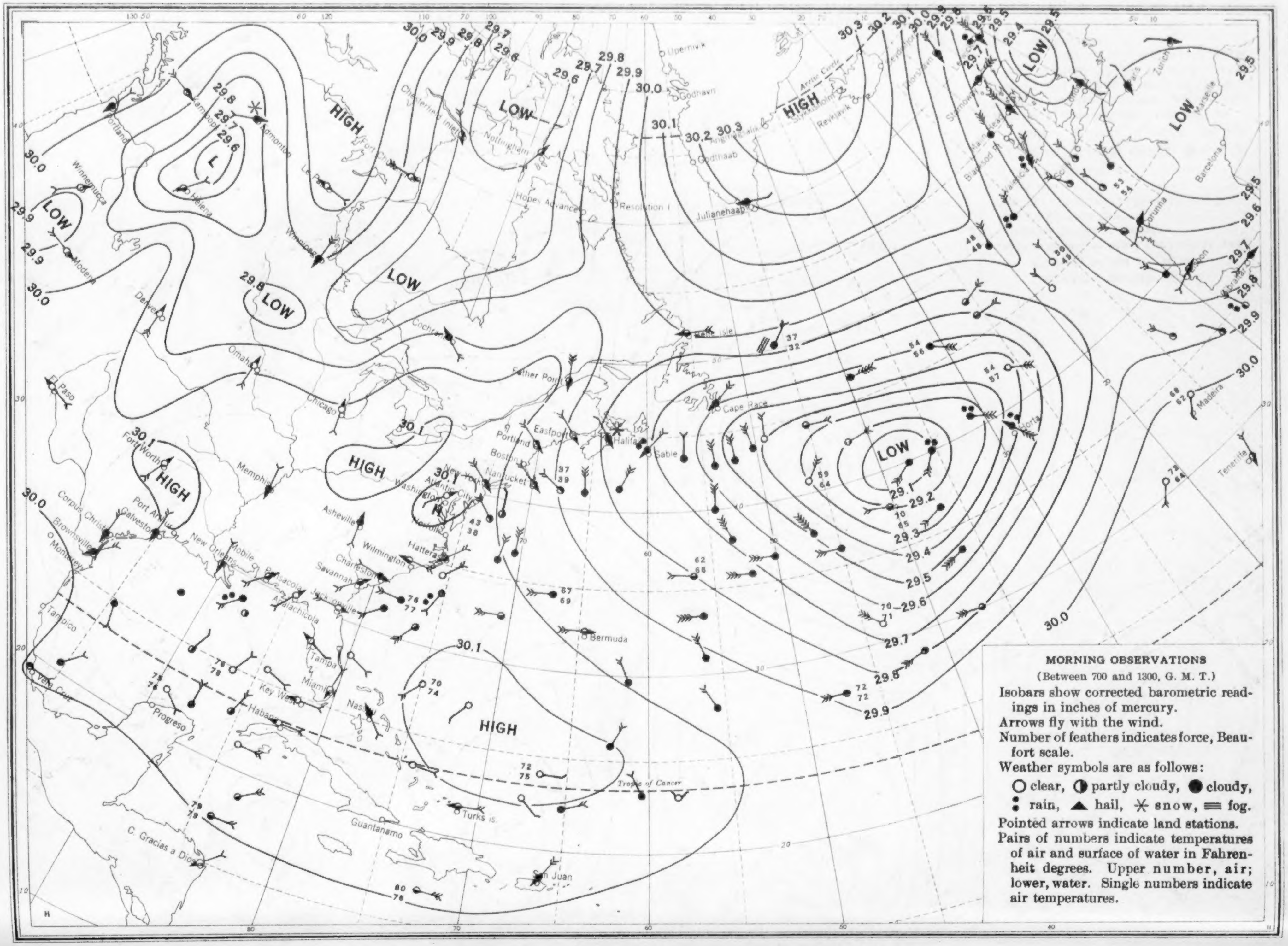


Chart X. Weather Map of North Atlantic Ocean, April 12, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart X. Weather Map of North Atlantic Ocean, April 12, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)

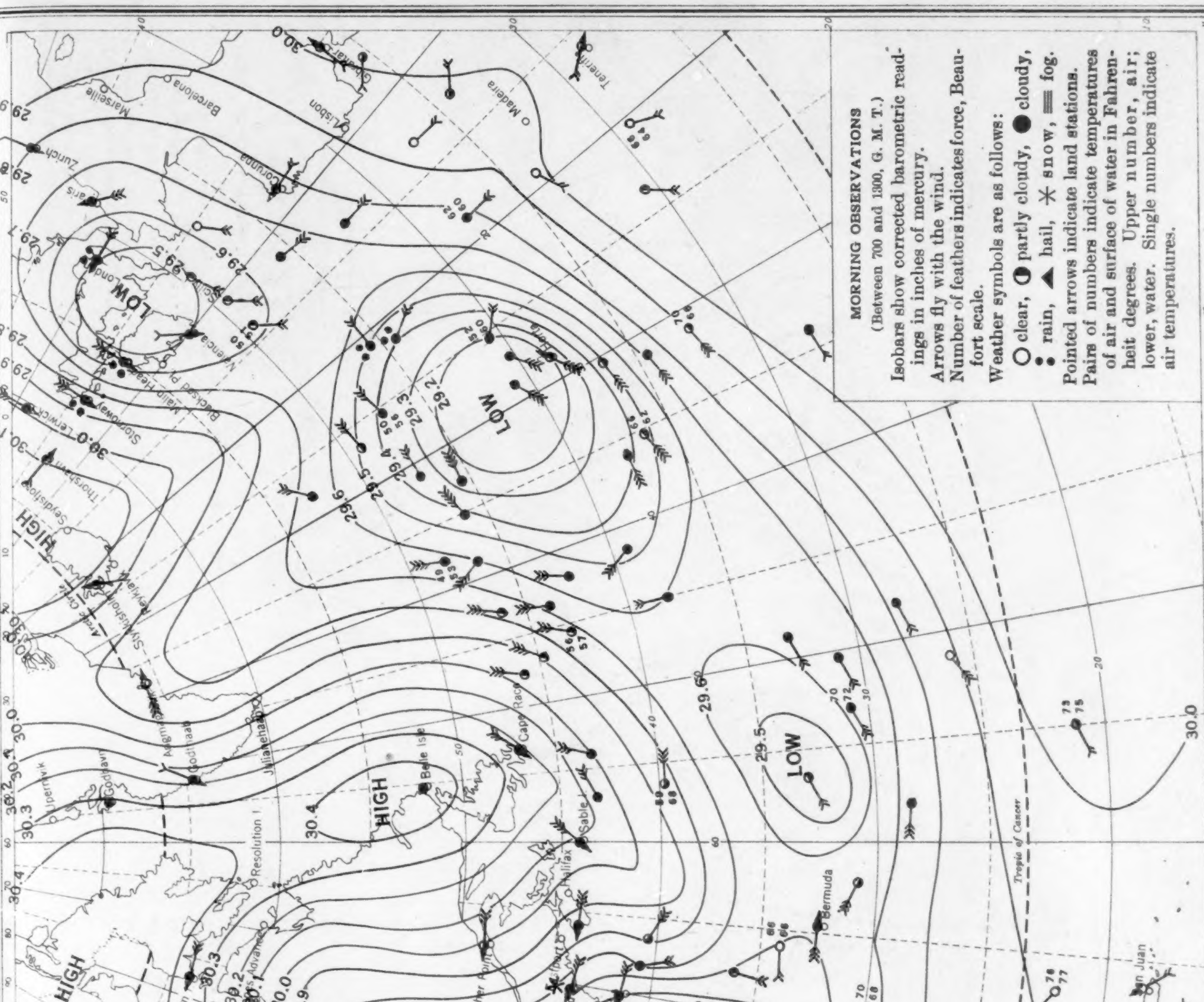
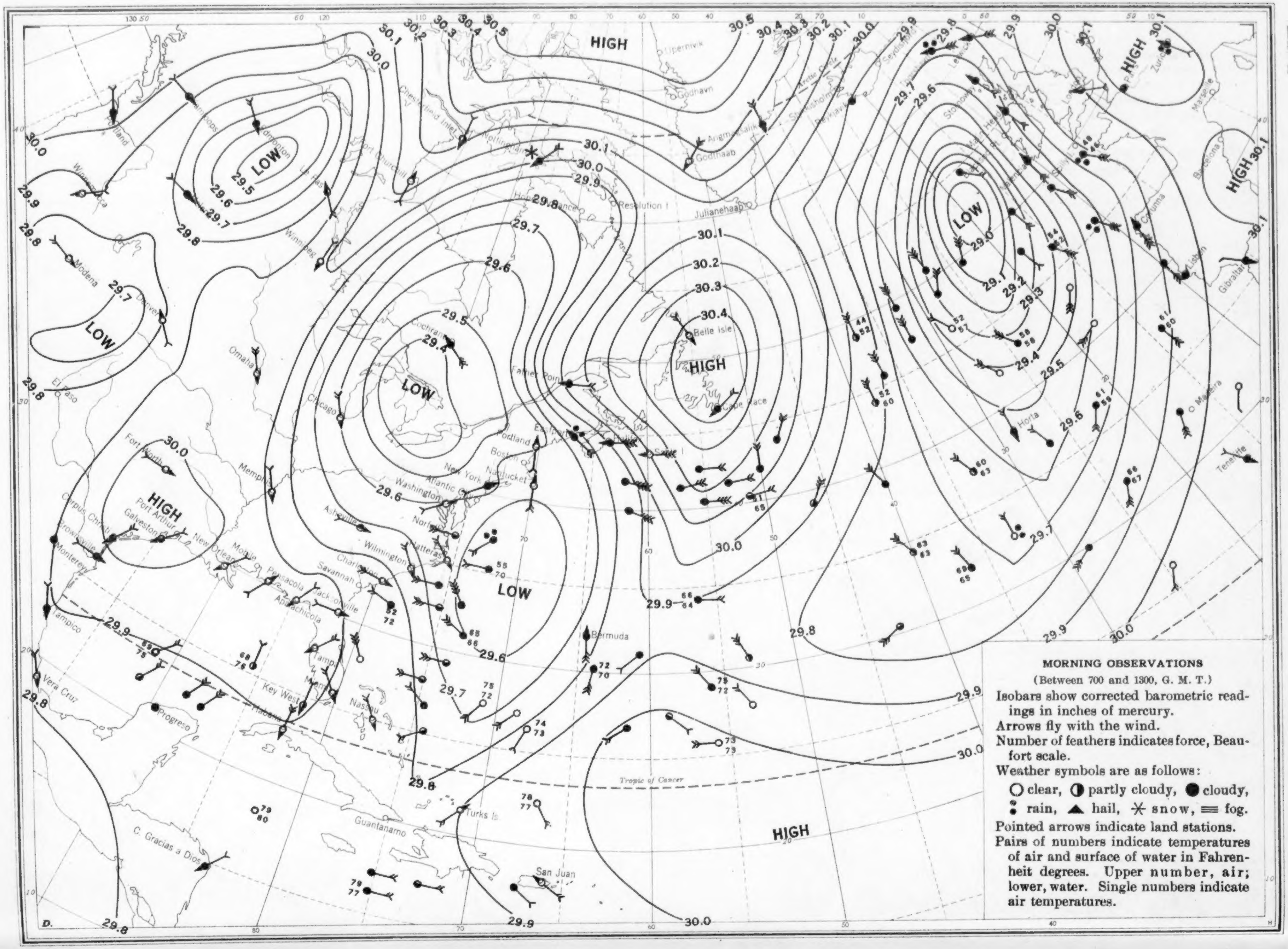


Chart XI. Weather Map of North Atlantic Ocean, April 13, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.